Once again, this schedule includes a strength training performance evaluation on Monday, that is, five days prior to a control run or race. The *late-cycle* weight training progression would be conducted during this strength training performance evaluation (See Table 8.3).

Sharpening Period Strength Training Schedule For Workweeks

Monday: Acquisitive upper and lower body strength training session before the passive recovery running workout

Tuesday: Recovery upper and lower body strength training session, recreational swimming preferred after the 3/4-effort running workout

Wednesday: Recovery upper and lower body strength training session after the active recovery running workout

Thursday: Recovery upper and lower body strength training session, recreational swimming preferred after the 1/2-effort running workout

Friday: Acquisitive upper and lower body strength training session before the active recovery running workout

Saturday: Recovery upper and lower body strength training session, recreational swimming preferred after the acquisitive running workout

Sunday: No strength training, easy long run

This schedule would permit two acquisitive upper and lower body weight-training sessions, conducted on Monday and Friday during the sharpening period, thus alternating three to four days apart. The *mid-cycle* weight training progression would be used during the Monday acquisitive strength training session, and the *late-cycle* progression would be used during the Friday session (See Table 8.3). The practical effect is to permit some strength acquisition, but at a reduced rate and with considerably less investment of time and energy. This will enable athletes to focus on the demanding sharpening work during this time.

Once again, the strength training sessions during the sharpening period are placed to minimize suppression of the quality running sessions normally run on Tuesday (3/4-effort), Thursday (1/2-effort) and Saturday (3/4-effort). The preferred mode of active recovery after the running workouts of Tuesday, Thursday and Saturday would be recreational swimming. In addition, the recovery upper and lower body sessions on Wednesday would focus on body weight exercises. Sunday would then essentially be a day off with regard to strength training, but whenever possible the long aerobic effort should be run on natural surfaces. Obviously, assigning particular tasks to various days of the week is only intended to serve as an illustration, since it is the pattern and integration of activities that is most important.

Sharpening Period Strength Training Schedule For Worthwhile Break

Monday: Upper and lower body strength maintenance session before the passive recovery running workout

Tuesday: Recovery upper and lower body strength training session, recreational swimming preferred, after the time trial

Wednesday: Recovery upper and lower body strength training session after the active recovery running workout

Thursday: No strength training, easy recovery running workout

Friday: No strength training, Day Before Race running workout

Saturday: Recovery upper and lower body strength training session, recreational swimming preferred after the competition

Sunday: No strength training, easy long run

During the worthwhile break in the middle of the sharpening period, a single strength maintenance session comes on Monday, that is, five days prior to a Saturday competition. The *peak period* weight training progression would be used in the Monday maintenance session (See Table 8.3). The recovery upper and lower body session on Wednesday would consist of body weight exercises. Recreational swimming is the preferred mode for recovery after the Tuesday time trial and the Saturday competition.

Peak Period Strength Training Schedule

For The 9-to-10-Day Ascent to the Plateau of Peak Performance

9 Thursday: Recovery upper and lower body strength training session, recreational swimming preferred, after the last 3/4-effort running workout

8 Friday: Upper and lower body strength maintenance training session before the active recovery running workout

7 Saturday: Recovery upper and lower body strength training session, recreational swimming preferred, after the finishing speed running workout

6 Sunday: No strength training, easy long easy run

5 Monday: Upper and lower body strength maintenance training session before the passive recovery running workout

4 Tuesday: Recovery upper and lower body strength training session, recreational swimming preferred, after the time trial

3 Wednesday: Recovery upper and lower body strength training session, body weight exercises preferred, after active recovery workout

2 Thursday: No strength training, easy recovery running workout

1 Friday: No strength training, Day Before Race running workout

0 Saturday: Recovery upper and lower body strength training session, recreational swimming preferred, after the competition

Base Period and Hill Period Workweek

3 Acquisitive upper and lower body sessions
3+ Recovery upper and lower body sessions

Base Period and Hill Period Worthwhile Break

1 Performance evaluation/ stabilization upper and lower body session
2 Recovery upper and lower body sessions
1 Recovery lower body session

Sharpening Period Workweek

2 Acquisitive upper and lower body sessions
1 Recovery upper and lower body session with body weight exercises
3 Recovery upper and lower body sessions, recreational swimming preferred

Sharpening Period Worthwhile Break

1 Maintenance upper and lower body session
1 Recovery upper and lower body session
2 Recovery upper and lower body sessions, recreational swimming preferred

9-to-10-Day Ascent and Peak Period

1 Maintenance upper and lower body session 4-5 days preceding the time trials or race
X Number of recovery upper and lower body sessions after the time trials, finishing speed or races, recreational swimming preferred

TABLE 8.1—Overview of Athletic Season Strength Training Schedules

No acquisitive strength training sessions are conducted once the athletes begin the peak period. Table 8.1 summarizes this discussion.

Format Considerations for the Individual Strength Training Sessions

Again, the progression of primary weight training sessions during the base, hill and sharpening periods must follow the structure of the meso-cycles adopted in the competitive racing schedule. As a result, distance runners have more frequent cycles and rapid weight training progressions, compared to those of athletes in other sports, such as American football.

An effective means of inducing muscular hypertrophy would be to direct exercises towards a particular muscle group with numerous sets and reps in the range of 80% maximal effort, and take brief recovery periods to keep the muscles hot and pumped. However, runners desire to pack the highest possible level of muscular strength into their competitive body weight. Unlike football players or throwers, they are not interested in muscular hypertrophy or gains in competitive body weight, because normally this would lower their aerobic ability and be counterproductive to performance.

The distance runner must then take a more intensive, quality-oriented approach to strength training. As a result, the number of sets in a distance runner's weight training program will be limited, and the progressions will also include fewer reps. The weight training progression is also faster, given the brevity of the meso-cycles dictated by the racing schedule. Also, the sets and reps within a given training session (and in the larger progression) will normally reduce in volume, and progress in intensity. This process will possibly culminate in maximum lifts at the end of each worthwhile break prior to the next training meso-cycle (See the *late cycle* training session in Table 8.3).

The limited number of sets and reps tends to offset the fact that distance runners generally lift intensively—that is, above 80% maximal effort, which could otherwise induce muscular hypertrophy. Distance runners should also take care to widely separate exercises that would cumulatively load-up specific muscle groups. For this reason, they might conduct roaming sets, proceeding from station to station in a series, as opposed to doing three straight sets of a given exercise. Some call this super-setting, whereas others use the same term to describe just the opposite practice. Distance runners might be advised to conduct three sets by doing three passes at a larger series of exercises that do not cumulatively load a specific muscle group.

In contrast with the arm exercises, athletes should not attempt a maximum in any of the primary or secondary leg exercises. And because of the greater strength of the primary leg muscles relative to the joints being stressed, athletes should not exceed 20 reps. Moreover, with reference to the legs, a maximum lift should not be characterized by fewer than six reps. The primary requirement is complete control. If this cannot be demonstrated, regardless of the weight involved, the activity should not proceed!

The *late cycle* or *peak cycle* training sessions in Table 8.3 would be conducted after the time trial or competition. At that time, the primary goal would be to maintain acquired strength levels and facilitate recovery. In order to maintain acquired powers with a minimal risk of injury and without introducing high fatigue levels, athletes should first conduct a warm-up set, and then a second set with the quality reduced to between 80 and 90% of the repetition maximum. This normally translates into a second set of four or five reps.

There is a practical limit to how much positive adaptation can be elicited by the combined running and strength training work loads. Accordingly, the risk of introducing high levels of fatigue or incurring injury can be a concern. However, by well structuring the strength training program, athletes can be in and out of the weight room within an hour. One-hour Maximum! In this way, high school athletes might be able to catch the early activity bus, and collegiate athletes can make supper at the dorms and be able to complete their studies.

The primary weight training progressions being provided are developmental in nature. As a result, they incorporate more volume than would be assumed by athletes who have already arrived, whose primary task is to maintain strength levels. Moreover, the progressions represent something near the developmental end point for mature specialists at 1,500 and 3,000 meters. Thus, the percent body weight (% BW) and repetition maximum (% RM) correspond to the desired performance guidelines (See Table 8.2). Obviously, athletes competing in 400 or 800 meters might increase their strength-training program approximately 15% over this example. On the other hand, those competing in 5,000 or 10,000 meters might decrease their program by the same amount. A truly comprehensive treatment would progress the schedules by physical age and athletic level, but that is beyond the scope of this book.

Acquisitive Upper Body Session

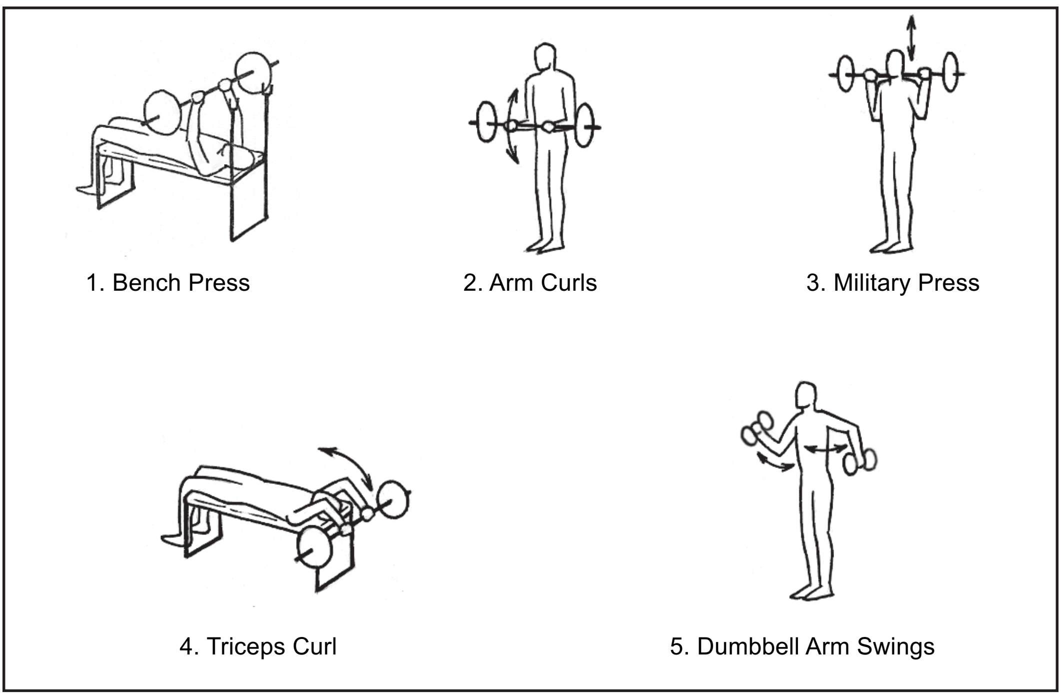


FIGURE 8.4—Strength Training Sessions

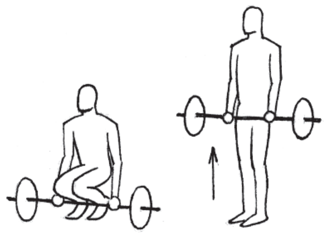
Acquisitive Lower Body Session

1. 1/4-Squat

2. Heel Raises

3. Step-Ups

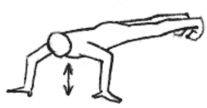
4. Walking Squat



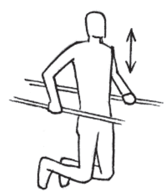
5. Dead Lift

Recovery Upper Body Session

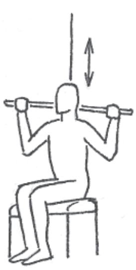
1. Pull-ups



2. Push-ups



3. Dips



4. Lats Pull Down

5. Rope Climb

6. Swimming

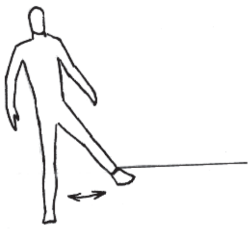
FIGURE 8.4 (continued)—Strength Training Sessions

Recovery Lower Body Session

1. Leg Extension

2. Leg Curls

3. Leg Abductor



4. Leg Abductor

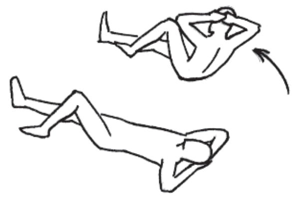
5. Biking

6. Swimming

Daily Abdominal Session

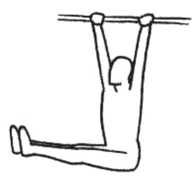
1. Sit-ups

2. Back-ups



3. Side-ups

4. Curl-over



5. L-sits

FIGURE 8.4 (continued)—Strength Training Sessions

Strength Training Performance Guidelines

Table 8.2 provides abstract strength training guidelines that are not specific by event. Athletes competing in the middle distance events should assume more extensive and higher quality strength training than those in the long distance events. These exercises do not exhaust the possibilities, but rather provide an appropriate indication of required strength levels.

Weight Training Progressions

Table 8.3 provides weight-training progressions for both the men's and women's primary upper body, and lower body exercises. Table 8.4 is based on Table 8.3, and can serve as a weight training workout card.

Male and Female Free Body Weight Exercises		
Pull-ups	Men	15 routine, 20 possible
	Women	10 routine, 15 possible
Push-ups	Men	50 routine, 75 possible
	Women	35 routine, 50 possible
Dips	Men	20 routine, 30 possible
	Women	10 routine, 20 possible
Sit-ups	Men	50 routine, 100 possible
	Women	50 routine, 100 possible
Back-ups	Men	25 routine
	Women	25 routine
Side-ups	Men	25 routine
	Women	25 routine
Curl over	Men	25 routine
	Women	15 routine
L-Sits	Men	20 routine
	Women	15 routine
Jumping Jacks	Men	100 routine
	Women	100 routine
Mountain Climb	Men	25 routine
	Women	25 routine
Reverse Splits	Men	25 routine
	Women	25 routine
Rope Climb	Men	1 Climb without using Legs
	Women	1 Climb using Legs

TABLE 8.2—Strength Training Performance Guidelines

Male and Female
Upper Body Free Weight Exercises

RM = Repetition Maximum = 1 Repetition at 100% Effort
BW = Quality Expressed as Percentage (%) of Body Weight

Bench Press	Men	1 x 150% BW
	Women	1 x 105% BW
Incline	Men	10 x 110% BW
	Women	10 x 75% BW
Military	Men	10 x 100% BW Standing
		10 x 75% Behind Head
	Women	10 x 70% BW Standing
		10 x 50% Behind Head
Flat Flies	Men	10 x 50% BW
	Women	10 x 35% BW
Arm Curls	Men	10 x 55% BW Normal
		10 x 50% Reverse
	Women	10 x 45% BW Normal
		10 x 40% Reverse
Triceps Curls	Men	10 x 50% BW
	Women	10 x 35% BW
Bent Rows	Men	10 x 75% BW
	Women	10 x 50% BW
Hang Cleans	Men	10 x 125% BW
	Women	10 x 75% BW

Male and Female
Lower Body Free Weight Exercises

Heel Raises	Men	10 x 125% BW
	Women	10 x 90% BW
Step-ups	Men	10 x 80% BW
	Women	10 x 55% BW
Walking Squats	Men	10 x 50% BW
	Women	10 x 35% BW
Dead Lift	Men	1 x 225% BW
	Women	1 x 150% BW
1/4 Squats	Men	6 x 225% BW
	Women	6 x 150% BW

TABLE 8.2 (continued)—Strength Training Performance Guidelines

Male Athletes
Upper Body Weight Training Progression

RM = 1 Repetition Maximum
RV = Reverse Curls
FR = Military Free Standing
BW = Body Weight
BH = Military Behind Head
WK = Walking Squats

Early-Cycle	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	20 x 50% RM	15 x 60% RM	10 x 70% RM
2) Arm Curls	15 x 40% BW	15 x 40% BW RV	10 x 50% BW
3) Military BH	20 x 40% BW	15 x 50% BW	10 x 60% BW
4) Triceps Curl	20 x 30% BW	15 x 40% BW	10 x 50% BW

Mid-Cycle	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	10 x 70% RM	6 x 80% RM	3 x 90% RM
2) Arm Curls	10 x 50% BW	10 x 50% BW RV	6 x 60% BW
3) Military BH	10 x 60% BW	6 x 80% BW	3 x 90% BW
4) Triceps Curl	10 x 50% BW	6 x 55% BW	3 x 60% BW

Late-Cycle (MAX)	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	10 x 65% RM	3 x 90% RM	1 x 100% RM
2) Arm Curls	10 x 40% BW	6 x 60% RV	3 x 70% BW
3) Military FR	10 x 60% RM	3 x 90% RM	1 x 100% RM
4) Triceps Curl	10 x 55% BW	3 x 60% BW	3 x 65% BW

Peak Period	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	10 x 65% RM	3 x 90% RM	—
2) Arm Curls	10 x 40% BW	6 x 60% BW	—
3) Military	10 x 60% BW BH	3 x 90% RM FR	—
4) Triceps Curl	10 x 40% BW	3 x 60% BW	—

TABLE 8.3

Male Athletes
Lower Body Weight Training Progression

RM = 1 Repetition Maximum	BW = Body Weight
RV = Reverse Curls	BH = Military Behind Head
FR = Military Free Standing	WK = Walking Squats

Early-Cycle	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squat	10 x 100% BW	10 x 125% BW	10 x 150% BW
2) Heel Raises	20 x 50% BW	10 x 80% BW	10 x 100% BW
3) Step Ups	10 x 45% BW	10 x 60% BW	10 x 70% BW
4) WK Squats	10 x 30% BW	10 x 40% BW	10 x 45% BW

Mid-Cycle	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squat	10 x 125% BW	8 x 175% BW	6 x 200% BW
2) Heel Raises	10 x 80% BW	10 x 100% BW	6 x 110% BW
3) Step Ups	10 x 60% BW	10 x 70% BW	10 x 75% BW
4) WK Squats	10 x 40% BW	10 x 45% BW	10 x 50% BW

Late-Cycle (MAX)	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squat	10 x 125% BW	6 x 175% BW	6 x 225% BW
2) Heel Raises	10 x 80% BW	6 x 100% BW	6 x 125% BW
3) Step Ups	10 x 60% BW	6 x 70% BW	6 x 80% BW
4) WK Squats	10 x 40% BW	6 x 45% BW	6 x 55% BW

Peak Period	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squat	10 x 125% BW	6 x 175% BW	—
2) Heel Raises	10 x 80% BW	6 x 100% BW	—
3) Step Ups	10 x 60% BW	6 x 70% BW	—
4) WK Squats	10 x 40% BW	6 x 45% BW	—

TABLE 8.3 (continued)

Female Athletes
Upper Body Weight Training Progression

RM = 1 Repetition Maximum	BW = Body Weight
RV = Reverse Curls	BH = Military Behind Head
FR = Military Free Standing	WK = Walking Squats

Early-Cycle	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	20 x 50% RM	15 x 60% RM	10 x 70% RM
2) Arm Curls	15 x 30% BW	15 x 30% BW RV	10 x 40% BW
3) Military BH	20 x 30% BW	15 x 35% BW	10 x 40% BW
4) Triceps Curl	20 x 20% BW	15 x 25% BW	10 x 30% BW

Mid-Cycle	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	10 x 70% RM	6 x 80% RM	3 x 90% RM
2) Arm Curls	10 x 40% BW	10 x 40% BW RV	6 x 50% BW
3) Military BH	10 x 40% BW	6 x 45% BW	3 x 55% BW
4) Triceps Curl	10 x 30% BW	6 x 35% BW	3 x 40% BW

Late-Cycle (MAX)	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	10 x 65% RM	3 x 90% RM	1 x 100% RM
2) Arm Curls	10 x 30% BW	6 x 50% BW	3 x 60% BW
3) Military FR	10 x 60% RM	3 x 90% RM	1 x 100% RM
4) Triceps Curl	10 x 35% BW	3 x 45% BW	3 x 55% BW

Peak Period	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	10 x 65% RM	3 x 90% RM	—
2) Arm Curls	10 x 30% BW	6 x 50% BW	—
3) Military	10 x 40% BW BH	3 x 90% RM FR	—
4) Triceps Curl	10 x 25% BW	3 x 45% BW	—

TABLE 8.3 (continued)

Female Athletes
Lower Body Weight Training Progression

RM = 1 Repetition Maximum	BW = Body Weight
RV = Reverse Curls	BH = Military Behind Head
FR = Military Free Standing	WK = Walking Squats

Early-Cycle	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squats	10 x 100% BW	10 x 125% BW	10 x 135% BW
2) Heel Raises	20 x 50% BW	10 x 70% BW	10 x 90% BW
3) Step Ups	10 x 25% BW	10 x 35% BW	10 x 45% BW
4) WK Squats	10 x 20% BW	10 x 25% BW	10 x 30% BW

Mid-Cycle	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squats	10 x 125% BW	8 x 135% BW	6 x 145% BW
2) Heel Raises	10 x 70% BW	10 x 80% BW	6 x 100% BW
3) Step Ups	10 x 35% BW	10 x 45% BW	10 x 55% BW
4) WK Squats	10 x 25% BW	10 x 30% BW	10 x 35% BW

Late-Cycle (MAX)	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squats	10 x 100% BW	6 x 130% BW	6 x 150% BW
2) Heel Raises	10 x 80% BW	6 x 100% BW	6 x 110% BW
3) Step Ups	10 x 35% BW	6 x 45% BW	6 x 55% BW
4) WK Squats	10 x 25% BW	6 x 30% BW	6 x 40% BW

Peak Period	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squat	10 x 125% BW	6 x 130% BW	—
2) Heel Raises	10 x 80% BW	6 x 90% BW	—
3) Step Ups	10 x 35% BW	6 x 45% BW	—
4) WK Squats	10 x 25% BW	6 x 30% BW	—

TABLE 8.3 (continued)

Workout Card
Male and Female Athletes
Upper Body Weight Training Progression

RM = 1 Repetition Maximum	BW = Body Weight
RV = Reverse Curls	BH = Military Behind Head
FR = Military Free Standing	WK = Walking Squats

Early-Cycle	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	20 x	15 x	10 x
2) Arm Curls	15 x	15 x RV	10 x
3) Military BH	20 x	15 x	10 x
4) Triceps Curl	20 x	15 x	10 x

Mid-Cycle	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	10 x	6 x	3 x
2) Arm Curls	10 x	10 x RV	6 x
3) Military BH	10 x	6 x	3 x
4) Triceps Curl	10 x	6 x	3 x

Late-Cycle (MAX)	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	10 x	3 x	1 x
2) Arm Curls	10 x	6 x	3 x
3) Military FR	10 x	3 x	1 x
4) Triceps Curl	10 x	3 x	3 x

Peak Period	**Set 1**	**Set 2**	**Set 3**
1) Bench Press	10 x	3 x	
2) Arm Curls	10 x	6 x	
3) Military	10 x BH	3 x FR	
4) Triceps Curl	10 x	3 x	

NAME: ______________________________

DATE: ______________________________

TABLE 8.4

Workout Card
Male and Female Athletes
Lower Body Weight Training Progression

RM = 1 Repetition Maximum
RV = Reverse Curls
FR = Military Free Standing
BW = Body Weight
BH = Military Behind Head
WK = Walking Squats

Early-Cycle	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squat	10 x	10 x	10 x
2) Heel Raises	20 x	10 x	10 x
3) Step Ups	10 x	10 x	10 x
4) WK Squats	10 x	10 x	10 x

Mid-Cycle	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squat	10 x	8 x	6 x
2) Heel Raises	10 x	10 x	6 x
3) Step Ups	10 x	10 x	10 x
4) WK Squats	10 x	10 x	10 x

Late-Cycle (MAX)	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squat	10 x	6 x	6 x
2) Heel Raises	10 x	6 x	6 x
3) Step Ups	10 x	6 x	6 x
4) WK Squats	10 x	6 x	6 x

Peak Period	**Set 1**	**Set 2**	**Set 3**
1) 1/4 Squat	10 x	6 x	
2) Heel Raises	10 x	6 x	
3) Step Ups	10 x	6 x	
4) WK Squats	10 x	6 x	

NAME: ______________________________

DATE: ______________________________

TABLE 8.4 (continued)

Beyond the Physical Aspects of Strength Training

This chapter has been largely devoted to physical aspects of strength training and athletic performance. However, the mental or spiritual contribution is equally important. It has been said that everything lies in the execution, and this requires an integration of concentration, timing, and focus. These qualities and abilities derive from a wider process of personal cultivation.

> ***Mind and body are but two aspects of the one reality: energy. One informs the other. The "informing" is found in the combined exercise of meditation flowing into concentration flowing into focus.***
>
> ***When an individual converts concentration into action, the movement is called focus. A vitalized mental image becomes a physical reality. The combination of concentration and focus intensifies power two-, four-, ten-fold.***
>
> —Sang Kyu Shim

When teaching any physical activity, at some point, athletes can be enlightened to mentally project in time and space the desired physical action and result. This important subject falls into the realm of sports psychology, and lies beyond the scope of this book. In brief, the optimal performance state transcends a superficial causal explanation. Athletics at the highest level is ultimately an art form. In this regard, the role of the deeper personality cannot be overstressed.

> ***For the superlative athletic performances of the future, a contemplation of, and some understanding of, the highest forms of art, music and philosophy can be seen as a sine qua non of the era of new world records...***
>
> ***A superlative performance does not merely require a few grimaces in the last stages of a race, but the capacity of the athlete to fully express himself—in every way open to him, through his strength, stamina and technique; his spirituality, which will supply the inner strengths: and his artistic response, which will make his physical movements more efficient and successful.***
>
> —Percy Cerutty

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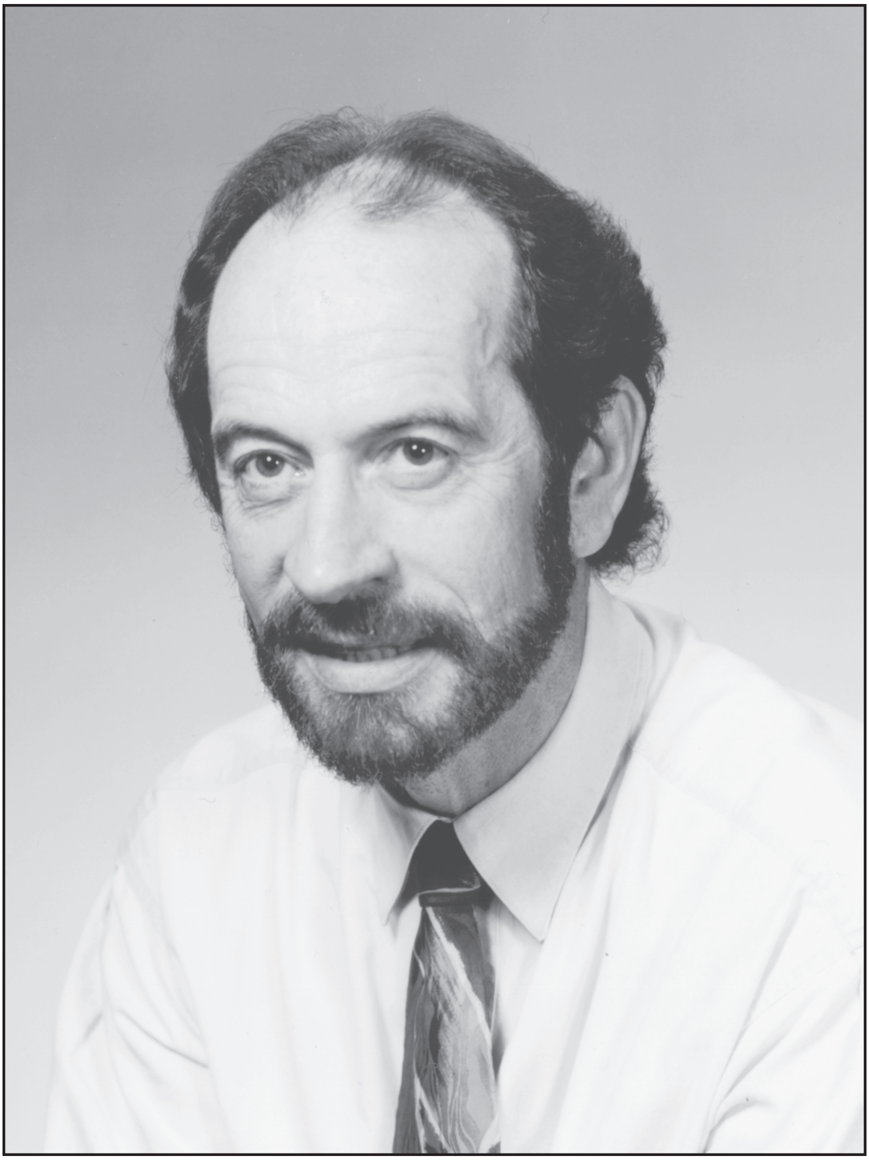

PHOTO 9.1—Peter Cavanagh, educator at Penn State University, and a pioneer of modern footwear research. Photo courtesy of Peter Cavanagh.

CHAPTER 9

Injuries and Athletic Shoes

When you have questions about your health or that of someone for whom you are responsible, always consult a qualified medical professional such as a doctor, podiatrist, or physical therapist. Consider the following suggestions about the possible origin, rehabilitation and prevention of athletic injuries. Share whatever information you feel may be of interest or assistance with a health professional. Because this chapter deals with athletic shoes, you should know that the author has a connection with the athletic footwear industry as a former employee of Nike, Inc., but also as an independent consultant and inventor. However, the beliefs and opinions expressed herein are the author's, and do not reflect those of any other individual or company.

Functional Footwear Versus the Consumer Feeding Frenzy

Military and safety footwear have specifications, and there are industry standards for certain footwear materials and components, but there is no government or private agency regulating the footwear industry. Footwear designers and companies are relatively free to do as they wish. Practically speaking, the only real check upon the footwear industry is the footwear industry. Between the companies there is some level of scrutiny regarding the claims of competitor products concerning their performance. Occasionally, if one company makes a blatantly false statement, or grossly misrepresents another competitor's product, then the irritated party will let the other know by taking legal action.

However, the great and final arbiter of what the footwear industry does or doesn't do is the consumer, and general public. Unfortunately, the public often lacks sufficient information to make prudent decisions when selecting athletic footwear. It can be difficult for consumers to separate reality from the nonsense often present in the marketing blurbs provided by major manufacturers. Further, most researchers who are well educated on the subject are gainfully employed by the footwear manufacturers. Moreover, their published works are steeped in scientific jargon, and not well known to the public. Coaches, who might have valid insights and contributions, generally do not have a mastery of the scientific literature, neither do they often publish their observations and conclusions.

The consumer looking for an article of footwear needs to have answers to some basic questions: Does the shoe fit foot properly? Is it comfortable? Does it provide adequate cushioning? Does it provide stability? Does it provide good traction? What is the shoe's expected service life? These questions are increas-

ingly becoming difficult if not impossible to answer, given the accelerating rate at which new products are being introduced.

This constitutes the second major problem facing those searching for functional athletic footwear. In the past, new footwear designs were introduced relatively infrequently, thus a particular model would be available for several years. Presently, new products are being launched three to five times a year. If an individual manages to find a good product, they are unlikely to find it again. Instead, when they next go shopping for footwear, they must once again take their chance at the roulette wheel and make their best guess.

Is there someone to blame? Everybody and nobody, since there are some large, impersonal, amoral forces at work. Consumer goods, such as a pair of athletic shoes, can be viewed as an essential tool. However, they can also constitute symbols with secondary meanings. "Goods carry meanings, and consumers buy goods to get hold of those meanings and use them to construct the self" (McCraken, 1988). In other words, the herd instinct is alive and well. People sometimes judge themselves and others by the external symbols they accumulate to communicate who they are—or at least, who they want to be. In this respect, how different are humans from bower birds that collect all sorts of interesting, shiny stuff to attain social status and attract a mate? Obviously, the mentality of our culture of consumption is a trap and an illusion. Individuals who literally buy into it are living in denial. In particular, relatively insecure young people, who have not yet matured and discovered their true self, often use external symbols and their stereotypical meanings as a substitute.

> ***Symbols are transitory—they come and go. Chasing symbols is like settling for the map instead of the territory. It creates anxiety. It ends up making you feel hollow and empty inside, because you exchange your Self for symbols of your Self.***
>
> —Deepak Chopra

The so-called "consumer" may not be a fit athlete, rather, a so-called "ordinary" person. In truth, we are all unique, extra-ordinary people. To have dignity or worth, we do not need to be anyone else, or collect symbols to fool ourselves or others about who we are. The letterhead of Hee-Jin Kim, an expert on Zen Master Dōgen, bears the following quote from Abraham Heschel: "Just to be is a blessing. "Just to live is holy" (Kim, 1987). What is the driving force behind the appeals made to sex, youth, and rebellion so often seen in modern advertising? Denial of mortality—denial of death. More importantly—denial of the true Self. Yes, denial of that which is truly unique and individual, and replacing it with a branded stereotype or caricature of "the individual." The truth is, we all die. As my father once said, "Armageddon, or the end of the world, comes for many

people every day." No one survives life. And we can take no material thing with us. Embrace the fact. Transcend it. It may transform the nature of your life.

At the present time, consumers have an insatiable thirst for the new—for change—and corporations are responding with more numerous and faster product introductions. And corporations, in the business of making profits for shareholders, fan the feeding frenzy, thereby pursuing the best interest of the amoral corporation, since its primary guiding principle is the dollar. The result of this escalation is a consumption monster that neither party really controls. Those consumers looking for functional footwear will have to look long and hard, and perhaps without success. Those wanting to make a good product within a corporation will have an uphill battle in making corporate "cents," when it is much easier to feed the frenzy and enjoy so-called success. Athletes may have to spend quite some time to actually identify those functional footwear presently being made by various manufacturers. Three months from now most of those shoes will likely be gone, and there may be little or no continuity with what comes next. The baby is often thrown out with the bath water.

Realize that you are the consumer, and the consumer is still king. If you want to continue to buy shoes that are pretty, cool, or have gizmos, then go ahead and do it. This is a free country and people are permitted life, liberty and the pursuit of happiness—even the pursuit of foolishness. But if you are after a functional article of footwear, then open your eyes, start demanding it and don't be shy. The best advice is "buyer beware." As the famous newscaster Walter Cronkite might have concluded: "And that's the way it is—."

Achilles Tendonitis

Achilles tendonitis can be caused by an acute trauma, and occasionally an athlete will tear or rupture the Achilles tendon during training or competition, but this is an infrequent occurrence. Most Achilles tendon problems come from training overloads and training errors. For example, an athlete who dramatically increases mileage or conducts quality work without a sufficient warm up, might become injured. Get the full story of what happened, and when. Inquire as to the athlete's history of injury, and then consider the individual's conformance, biomechanics, training practices and footwear.

Roads Aren't Made for Running

Always check for an anatomical leg length difference. However, it could be that a functional leg length difference exists due to the athlete often running across a grade. Sidewalks commonly decline about five degrees towards the curb. And to promote effective runoff and drainage, roads commonly decline from the crown or centerline by about five degrees toward the opposing curbs. Therefore, the only area an athlete can find a level grade on many modern roads is right down the middle. Obviously, running in this location is generally not advisable.

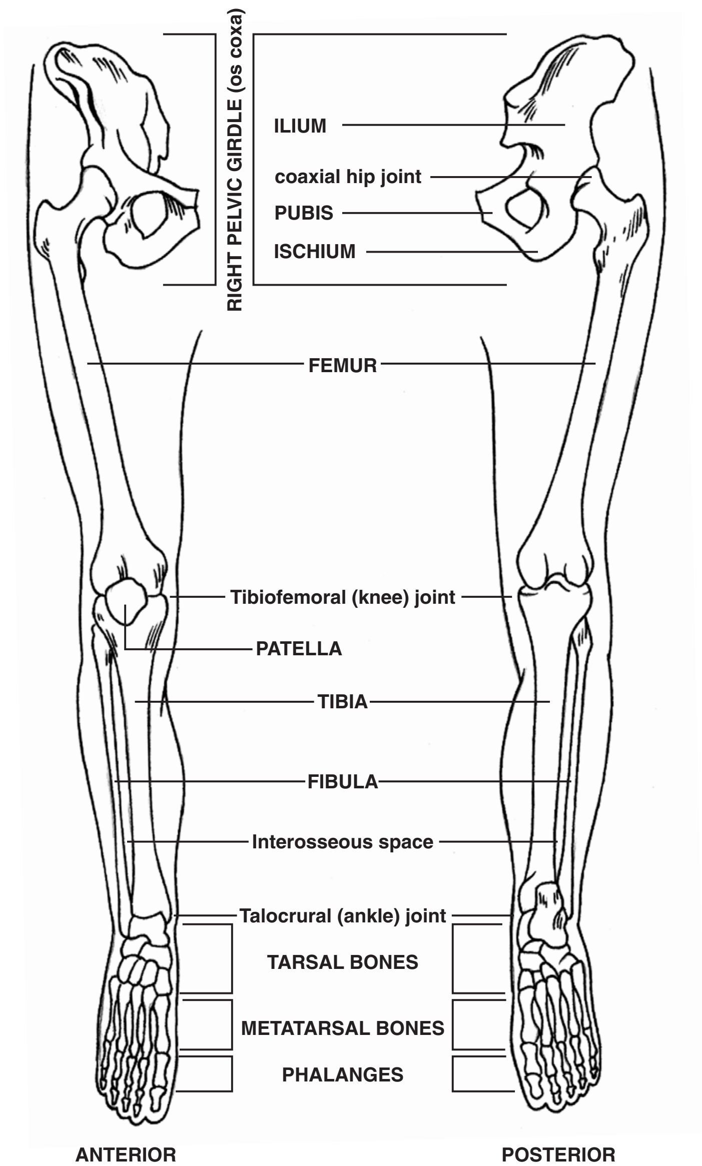

FIGURE 9.1—Anterior and posterior views of the bones of the lower extremities

Realize that over a relatively short distance, a grade of five degrees can result in a change in elevation of about 1/4 inch. When an athlete runs across a grade, the resulting functional leg length difference can displace and cause injury to the pelvis and lower back. Conversely, if an individual has an anatomical or true leg length difference, it is actually possible to compensate and neutralize the difference by selecting the proper position on the grade of a road or sidewalk upon which to run, but this is not the best solution. The introduction of a lift or orthotic by a trained medical professional can provide more appropriate relief.

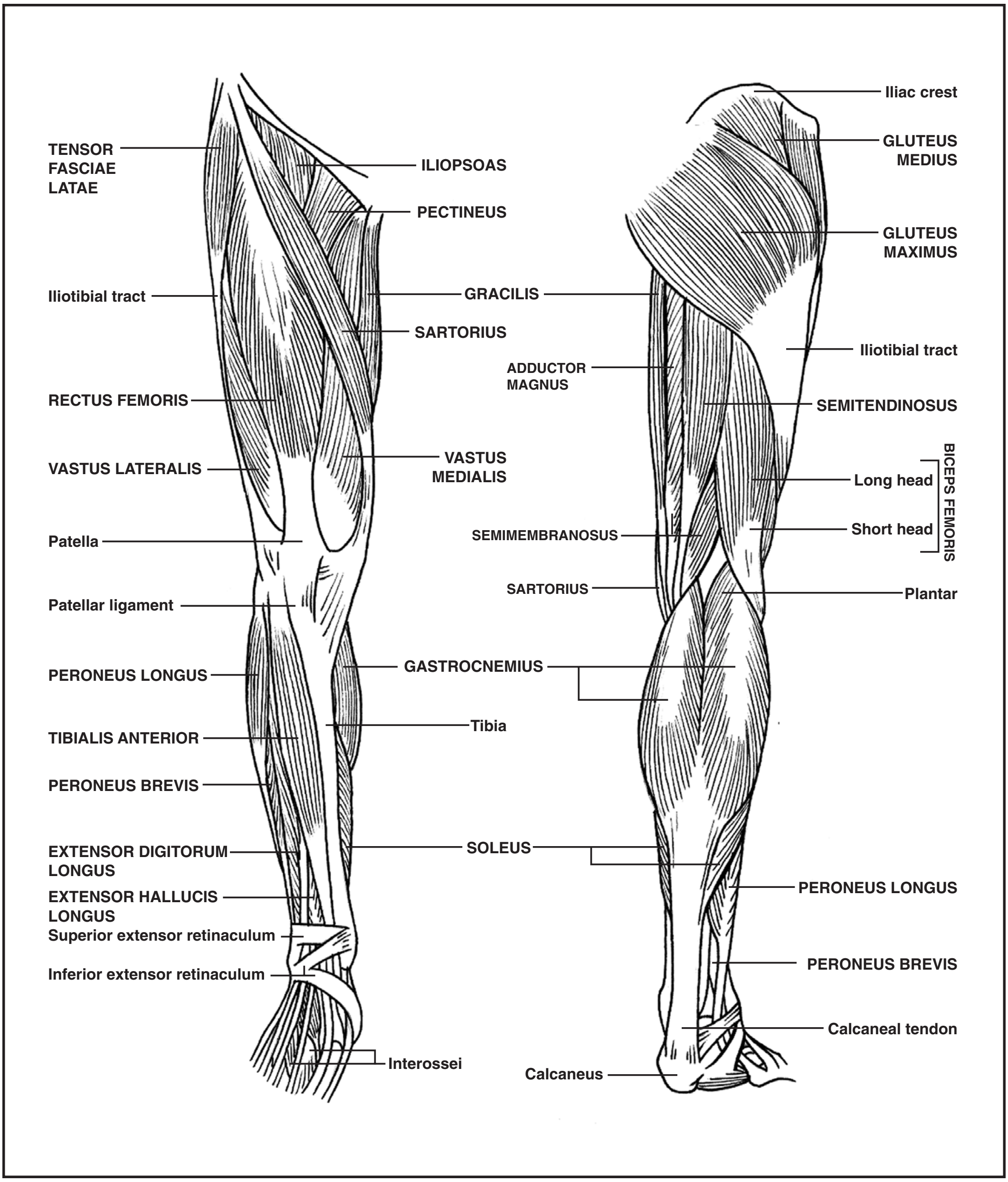

FIGURE 9.2—Anterior and posterior views of the muscles of the lower extremities

Warm-Up

Athletes need to properly warm up before performing high quality work. Breaking a sweat and attaining a pulse of 120 bpm are signs of a successful warm-up. However, even jogging two to three miles at an easy 1/4-effort, then running half a dozen stride-outs to break a sweat and attain a pulse of 120 bpm does not always provide an adequate warm-up for optimal performance. For better results, run three to four miles at 1/4-effort, and then include a faster segment close to your anaerobic threshold for about 2:30 to 3:00 minutes. Stride-outs can then follow this routine.

Tendons Like It Hot

In colder climates, or during the winter season, it is wise to protect the Achilles tendon. At times, the area between the collar of the shoe and the athlete's warm-ups can become exposed. The athlete's socks could sag or not be sufficiently heavy or windproof to protect the Achilles tendon. Further, the velocity of the lower limb and foot during running can exceed 50 mph. When an athlete is out in sub-zero weather, realize that the wind chill is being compounded at the hands and feet. A temperature gradient or cool area across the Achilles tendon can contribute to the onset of an injury.

Gimme Them Low Heeled Sneakers

Sudden or frequent changes in heel elevations can also lead to injury of the Achilles tendon. Occasionally, an athlete will run in training shoes with a relatively high heel, and then don a pair of racing flats or spikes without sufficient warm-up, stretching, or transition to the new footwear. The difference in the heel elevation between dress or casual shoes and athletic shoes can also cause problems. Attempt to minimize frequent changes in heel elevation, and insofar as possible, gradually progress the training loads when changing heel elevations.

Given the choice, gravitate towards footwear with lower heel elevation, since this normally lends itself to greater footwear stability and natural biomechanical function (Bates, James, and Osternig, 1979). Once an injury has occurred, it is often necessary to take pressure off the Achilles tendon by using a lift. The trick is to later phase out the use of the lift without re-injuring the tendon.

Time and Travel: As Things Speed Up Athletes Can Go Backwards

Injury to the Achilles tendon can also occur when, after hard exercise, an athlete must undergo a period of relative immobility. For example, perhaps the athlete runs a workout or engages in a competition, then travels in a vehicle for several hours. Given these circumstances, their connective tissue will often tighten up to a greater degree than normal. Traveling immediately after a hard workout or meet, even the following day, is not ideal. Whenever possible, travel on the second or third day after a hard training or racing effort. The worst situation occurs when an athlete performs hard exercise, then undergoes a period of relative immobility (where the initial warm-up is lost), and then later performs hard exercise again. This sometimes takes place when an athlete doubles or triples during a track and field meet, or participates in a multiple-stage relay event. These situations can be associated with a high risk of injury.

The Achilles Tendon and Shock

Excessive shock loading from repeated impact events can cause trauma to the Achilles tendon, and also disrupt the tendon's blood supply (MacLellan, 1984). The shock pulse or discontinuity from an impact event travels roughly at the speed of sound, approximately 1,600 meters per second in human soft tissue, and 3,200 meters per second in bone (Harris, 1988). The latter value is over three times faster than a high caliber rifle bullet! Further, sound has about five times more power in water than in air, and much of the human body consists of water.

One method the body uses to manage impact events is movement about a joint, associated with deflection and subsequent recovery in the manner of a spring, thus attenuating the impact event over time. An alternative method is to dampen the energy associated with an impact event and turn it into heat. Individual human muscles only dampen about 35% of the energy imparted to them (Greene and McMahon, 1979). The tendons provide a connection between bones and muscles in transferring loads, but they also become conduits for the shock pulse passing in and out of muscles. So-called “road-shock” can then be particularly stressful to tendons, which are less elastic and have a poorer blood supply than the muscles. Hard athletic shoes and hard roads are hard on the Achilles tendon.

Hard Shoes and Hard Surfaces

Athletic shoes with extremely low heel elevations, or forefoot to heel elevation differences less than 9-10 mm, can also place high loads on the Achilles tendon. This is due partly to the deflection of the fat pad on the heel. The fat pad normally deflects approximately 7-10 mm during impact. Within a pair of shoes this can contribute a negative heel elevation relative to the forefoot (Cavanagh, Valiant and Misevich, 1984). Many athletic shoes made during the 1960’s and early 1970’s had relatively hard soles, low heel elevations, and less than 9 mm difference in elevation between the forefoot and heel. Further, most runners in the United States train on hard asphalt. This was partly why Achilles tendonitis was such a common injury during that time (Cavanagh, *The Running Shoe Book*, 1980).

The most recent teachings of the athletic footwear industry comprise intellectual property. Accordingly, a number of United States patent documents will be cited and identified by their corresponding number. All of these documents can be found on the Internet at the U.S. Patent and Trademark website (www.uspto.gov). The fundamental idea behind the government granting a patent is the “exchange theory.” In exchange for the net social welfare benefit generated when inventors disclose and teach their inventions to the general public, they are granted a certain commercial exclusivity for a period of seventeen to twenty years. Readers wishing to learn about footwear may refer to the patents about to be cited via the aforementioned website.

Today, Achilles tendon injuries are less frequent than in previous years, due in part to higher heel elevations, which take some of the loads off the tendon. There have also been improvements in cushioning and stability, particularly in the rearfoot area of athletic footwear. One example is U.S. Patent 4,506,462, granted to Peter Cavanagh, and assigned to Puma AG (See Figure 9.3).

Other teachings relating to differential cushioning in the rearfoot area include:

- U.S. 4,364,189, granted to Barry Bates, assigned to ASICS Corp.
- U.S. 4,731,939, granted to Rui Parracho et al., assigned to Converse, Inc.
- U.S. 4,817,304, granted to Mark Parker et al., assigned to Nike, Inc.
- U.S. 4,934,072, granted to Ray Frederickson et al., assigned to Brooks Sports, Inc.

- U.S. 5,046,267, granted to Bruce Kilgore et al., assigned to Nike, Inc.
- U.S. 5,197,206, U.S. 5,197,207, and U.S. 5,201,125, granted to Martyn Shorten, assigned to Puma AG.
- U.S. 6,029,374, granted to Herr, et al.
- U.S. 6,266,897, granted to R. Seydel, S. Luthi, R. Fumi, K. Beard, and O. Kaiser, assigned to Adidas-Salomon AG.

And also patents on which the author is an inventor, including:

- U.S. 5,425,184, U.S. 5,625,964, and U.S. 6,055.746, entitled “Athletic Shoe With Rearfoot Strike Zone,” granted to Lyden et al., assigned to Nike, Inc. (See Figure 9.4)
- European Patent Application EP 0752216 A3, entitled “Footwear With Differential Cushioning Regions,” by Lyden, assigned to Nike, Inc.
- U.S. 5,921,004, entitled “Footwear With Stabilizers,” granted to Lyden, assigned to Nike, Inc.
- U.S. 6,449,878, granted to Lyden (see Figure 10.1)

Does The Shoe Bite?

If a portion of the Achilles tendon that may be in contact with the shoe becomes injured or painful, then look for a lump of material or for contact with the edge of a heel counter that could be irritating the tendon. The author once performed “shoe surgery” on an athlete’s track spikes a few days before the U.S. Olympic Trials because he was suddenly having Achilles tendon problems. The athlete was apprehensive at the sight of his track spikes being modified with a razor blade, but the operation provided him with immediate relief.

In addition, check to see if the athlete is wearing shoes that are too small, and in particular, examine their track spikes. Runners will often gravitate toward a smaller shoe size to get a snug fit, especially when they have narrow feet or motion control problems. Again, dress shoes can sometimes be the real problem. Often the stiff collar of a dress shoe can impinge upon the tendon. This can easily happen if an individual has one foot larger than the other. In some instances, a bursa on the back of the calcaneus can become injured, rather than the Achilles tendon. In this case, the pressure on the general area needs to be reduced. If this condition persists, the bursa itself could become injured beyond repair and need to be surgically removed.

Flexibility and Strength

Check the individual’s range of motion with respect to ankle and hip flexion. Stretching the calf muscles on an inclined platform is a sound training practice (Dellinger with Beres, 1978). What does the athlete do in the way of a stretching routine? Check the strength and condition of the athlete’s calf muscles. Weak calf muscles can result in excessive loads being placed on the Achilles tendon.

United States Patent [19]

Cavanagh

[11] Patent Number: 4,506,462

[45] Date of Patent: Mar. 26, 1985

[54] RUNNING SHOE SOLE WITH PRONATION LIMITING HEEL

[75] Inventor: **Peter R. Cavanagh,** Pine Grove Mills, Pa.

[73] Assignee: **Puma-Sportschuhfabriken Rudolf Dassler KG,** Herzogenaurach, Fed. Rep. of Germany

[21] Appl. No.: **387,667**

[22] Filed: **Jun. 11, 1982**

[51] **Int. Cl.**[3] **A43B 7/16**

[52] **U.S. Cl.** .... **36/92;** 36/114; 36/30 R; 36/31; 36/129

[58] **Field of Search** .... 36/35 A, 34 R, 37, 129, 36/92, 32 R, 30 R, 31, 114

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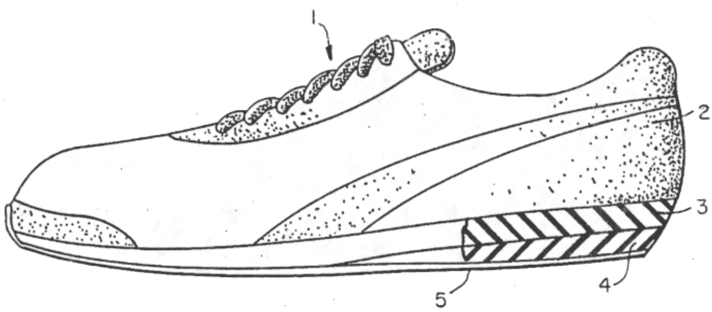
4,364,189	12/1982	Bates	36/129 X

Primary Examiner—Werner H. Schroeder
Assistant Examiner—Tracy Graveline
Attorney, Agent, or Firm—Sixbey, Friedman & Leedom

[57] **ABSTRACT**

A running shoe sole having a relatively thin outer sole layer of hard, wear-resistant material, a midsole layer resilient cushioning material and a heel sole layer, provided between the outer sole and midsole layers along approximately the rear half of the sole. In accordance with preferred embodiments, an outer, longitudinally extending portion of the heel sole layer spans approximately ⅔ of the width of the heel sole layer and is formed of a resilient cushioning material, while an inner portion spanning approximately the remaining ⅓ of the width of the sole layer is formed of a material that is of a hardness of approximately 10–20 shore durometer greater than that of the outer portion of the heel sole layer. This construction of the heel sole layer enables cushioning of the foot during lateral heel strikes occurring during running to be provided by the outer portion of the heel while the inner portion is able to act in a manner which limits pronation occurring thereafter.

8 Claims, 5 Drawing Figures



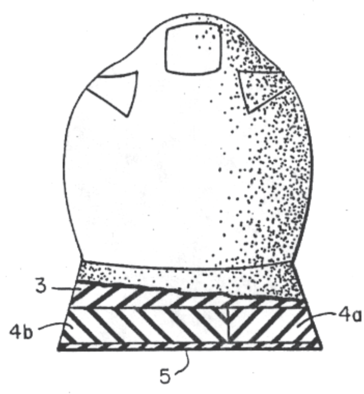


FIGURE 9.3—U.S. Patent 4,506,462

US005425184A

United States Patent [19]

Lyden et al.

[11] Patent Number: 5,425,184

[45] Date of Patent: Jun. 20, 1995

[54] ATHLETIC SHOE WITH REARFOOT STRIKE ZONE

[75] Inventors: **Robert M. Lyden; Gordon A. Valiant,** both of Beaverton; **Robert J. Lucas; Michael T. Donaghu,** both of Portland, all of Oreg.; **David M. Forland,** Battle Ground, Wash.; **Joel I. Passke,** Portland, Oreg.; **Thomas McGuirk,** Portland, Oreg.; **Lester Q. Lee,** Gaston, Oreg.

[73] Assignee: **Nike, Inc.,** Beaverton, Oreg.

[21] Appl. No.: **38,950**

[22] Filed: **Mar. 29, 1993**

[51] **Int. Cl.**[6] **A43B 13/20**

[52] **U.S. Cl.** .... **36/29;** 36/114; 36/59 C

[58] **Field of Search** .... 36/102, 88, 103, 114, 36/25 R, 28, 29, 34 R, 35 R, 35 B, 59 C

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Primary Examiner—Bryon P. Gehman
Assistant Examiner—Ted Kavanaugh
Attorney, Agent, or Firm—Banner, Birch, Mckie & Beckett

[57] **ABSTRACT**

An athletic shoe has a sole with a rearfoot strike zone segmented from the remaining heel area by a line of flexion which permits articulation of the strike zone during initial heel strike of a runner. The line of flexion is located to delimit a rearfoot strike zone reflecting the heel to toe running style of the majority of the running population. In addition to allowing articulation of the rearfoot strike zone about the line of flexion, the sole incorporates cushioning elements, including a resilient gas filled bladder, to provide differential cushioning characteristics in different parts of the heel, to attenuate force applications and shock associated with heel strike, without degrading footwear stability during subsequent phases of the running cycle. The line of flexion may be formed by various means including a deep groove, a line of relatively flexible midsole material, and a relatively flexible portion of a segmented fluid bladder.

47 Claims, 5 Drawing Sheets

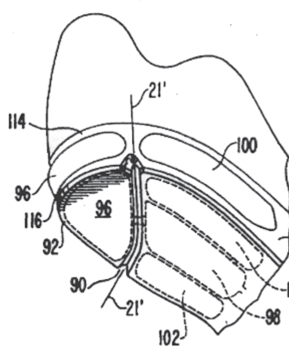

FIGURE 9.4—U.S. Patent 5,425,184

Wreck and Roll: Motion Control Out of Control

It may cause confusion to simply refer to any inward rotation of the foot—in particular, of the midfoot and forefoot—as pronation, because this word is generally used to describe rearfoot motion. Only recently has reliable three-dimensional equipment become available that may enable researchers to one day well understand rotation of the midfoot and forefoot. In this book, pronation will describe inward rotation associated with articulation of the sub-talar joint, and inward rotation will describe midfoot and forefoot motion.

During the 1960's and early 1970's Achilles tendon injuries were sometimes caused in part by low heel elevations and inadequate cushioning. Presently, the majority of Achilles tendon injuries are associated with motion control problems. Inward rotation of the foot (or pronation) and outward rotation (or supination) can place torque on the Achilles tendon (See Figure 9.5). Rearfoot pronation of the calcaneus (or heel) and inward rotation of the midfoot is associated with internal rotation of the tibia and lower leg. This internal rotation imparts a twist on the Achilles tendon. However, the use of proper shoes can reduce this motion.

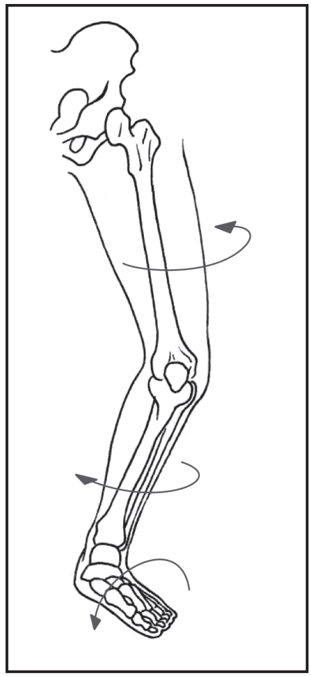

FIGURE 9.5
from Cavanagh, 1980

When running in many commercial athletic shoes, runners commonly exhibit 12-14° of rearfoot pronation (Edington, Frederick, and Cavanagh, 1990). Typically, when athletes run barefoot on grass, only about seven to eight degrees of rearfoot pronation occurs—that is, inward rotation of the calcaneus associated with articulation of the sub-talar joint. And they also tend to have less inward rotation of the midfoot and forefoot (See Figure 9.6).

In brief, the cushioning provided by higher heel elevations—and the longer effective lever arm created by the sole of athletic footwear—can double rearfoot pronation. Running barefoot on grass, an athlete can experience approximately the same magnitude of shock as running in well-cushioned shoes on asphalt (Unold, 1974). Moreover, an athlete running in sand can experience even less than on grass. So, in a perfect world we would all be "down under" in Portsea, Australia, running in the sand dunes where Herb Elliott trained. A practical alternative is to train on natural surfaces in athletic shoes having a relatively low heel elevation (See Figures 9.7 and 9.8).

Many of the athletic shoes made in the 1960's and early 1970's had soles too hard for running high mileage on asphalt streets, but otherwise adequate for running on natural surfaces. European runners at that time normally ran on natural surfaces, and that was the consumer on whom Adidas, AG, the major manufacturer of the time, was primarily focused. Because they did not pay attention to those individuals running on asphalt in the United States, companies such as Nike, Inc. came to the fore.

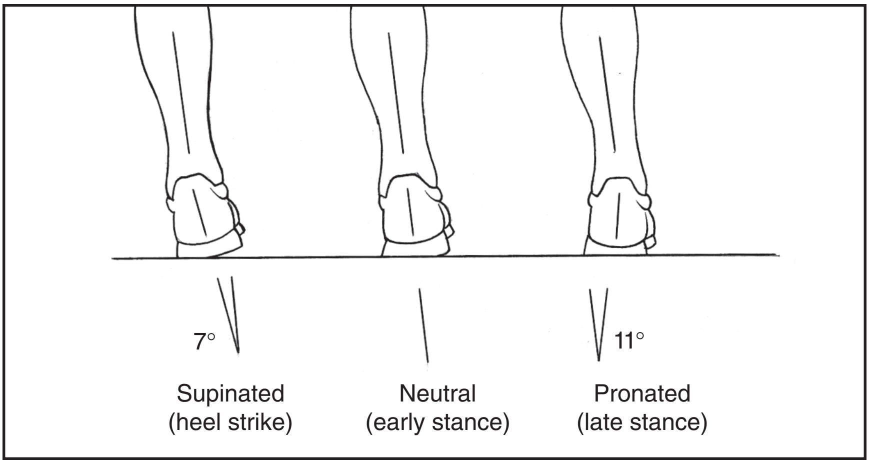

FIGURE 9.6

Numerous running shoes of this era included a foxing strip, or band of rubber bonded around the perimeter of the sole: the Converse All Star basketball shoe, the Adidas Olympia and Gazelle. This had the effect of stiffening the edges of the sole. It was undesirable for those areas of the sole receiving sudden impact loading when running on asphalt, but was beneficial in areas requiring motion control.

As discussed in detail in U.S. Patent 5,921,004, one of the fundamental weaknesses of the soles of many athletic shoes manufactured in the last twenty years is that most exhibit an edge effect—that is, when compressed they are approximately 30% less stiff about a substantial portion of the perimeter relative to the middle of the sole. Check for yourself if you trust your fingers. If an athlete experiences substantial inward or outward rotation, such footwear will do little to arrest this tendency. Instead, the article of footwear can actually facilitate it. For this reason, the author alternated running shoes having an edge effect (for running on asphalt) with shoes having a foxing strip (for running on natural surfaces). Thus, he attempted to have the best of both worlds. This practice eliminated the experience of knee pain and injury common during the 1960's and early 1970's.

The following two patents teach ways of reducing stiffness in a central portion of the rearfoot area of the sole to enhance stability and cushioning—U.S. Patent 4,043,058, granted to Geoffrey Hollister, et al., and U.S. Patent 4,364,189 granted to Tom Clarke et al., assigned to Nike, Inc. Conversely, the next two patents teach ways of stiffening up the edges of a sole relative to the central portion—U.S. Patent 4,302,892, granted to Jaroslav Adamik, and U.S. Patent 4,288,929, granted to Edward Norton, assigned to New Balance Athletic Shoes, Inc. Some of these teachings can counteract the edge effect apparent in many modern athletic shoes, but they do not find their way into athletic footwear on a regular basis. Moreover, positioning a relatively stiff foam material in the lateral rear corner of the sole can sometimes compromise both cushioning and rearfoot stability. Again, see the patents directed towards optimizing both cushioning and stability, cited on pages 275-276.

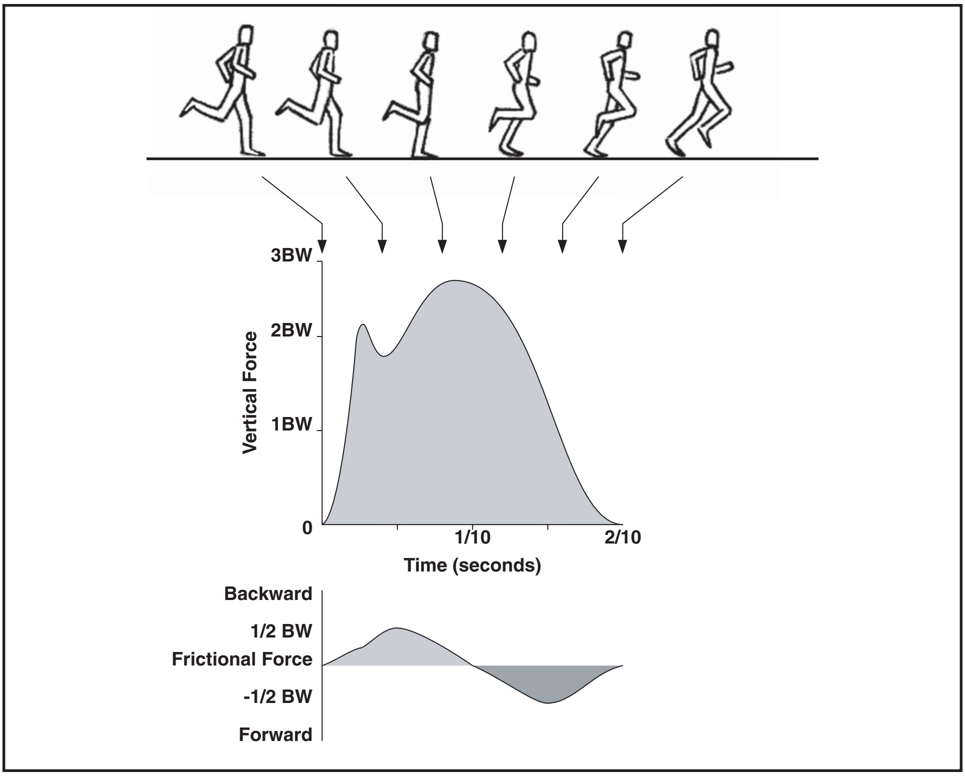

FIGURE 9.7—Ground reaction forces in body weight units during running (from Cavanagh, 1980)

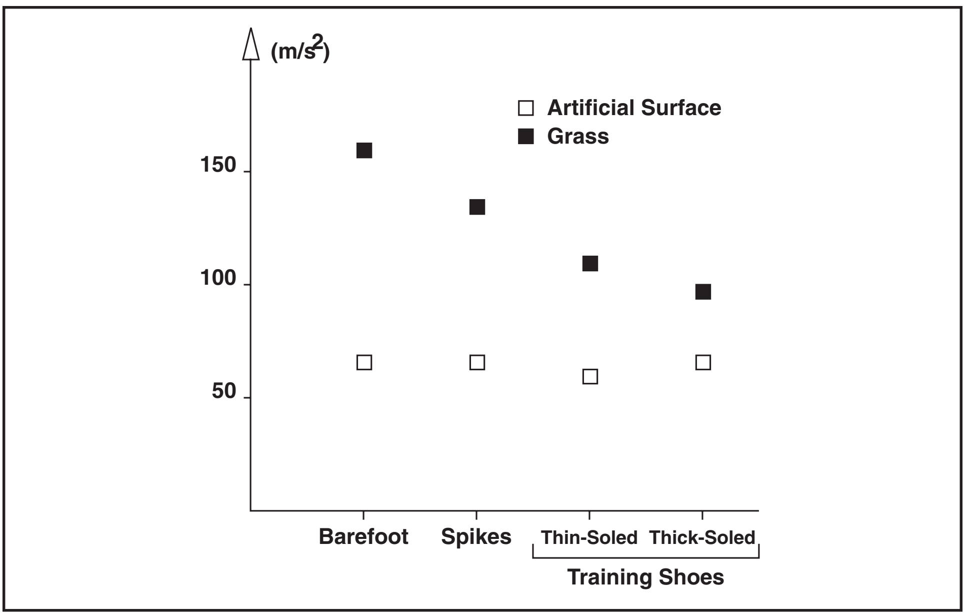

FIGURE 9.8—Mean values for the heel acceleration in heel-toe running with different footwear on grass and synthetic surface for 5 subjects, 10 trials each at a running velocity of about 4 m/s (from Unold, 1974)

FIGURE 9.9—Rear view of runner showing pronation and resulting whip

FIGURE 9.10—Examples of arches

What Happens on the Ground Determines What Happens in the Air

The presence of a whip—that is, a circular deviation of an athlete's foot and lower leg during the so-called "flight phase" when the foot is in the air—can indicate a motion control problem. In this regard, what happens on the ground determines what happens in the air. For example, if the runner's foot rotates inward and does not recover to a more neutral position by toe-off, then the ground reaction force of this action will normally cause the foot to displace laterally upon toe-off, causing a visible circular whip during the flight phase. This whip normally imparts a twist to the Achilles tendon, and also works against the lateral side of the knee (See Figure 9.9).

Check Conformance

Check the athlete's conformance for any potential structural dispositions to injury. What is the athlete's Q-angle from the hip? Is the individual bow-legged? Does the athlete have normal, flat, or high arches? See Figure 9.10 for examples of each.

Often, individuals with flat feet have a *forefoot varus* condition. When their foot is in a non-weight-bearing neutral position, their forefoot has the first toe in an elevated position relative to the fifth toe. In order to compensate for this and bring the first toe to the support surface during weight-bearing, the subtalar joint must articulate, causing pronation, that is, the individual's heel tilts inward. An athlete with flat feet can also load the midfoot area about the navicular and medial longitudinal arch to a greater degree than other individuals. Accordingly, the athlete can become injured by using a curve lasted shoe (which does not provide support in this area). Instead, the individual may benefit from arch supports and orthotic posting of the medial longitudinal arch by a trained medical professional. Those with normal arches tend to have a more neutral stance. However, those with high arches often have a

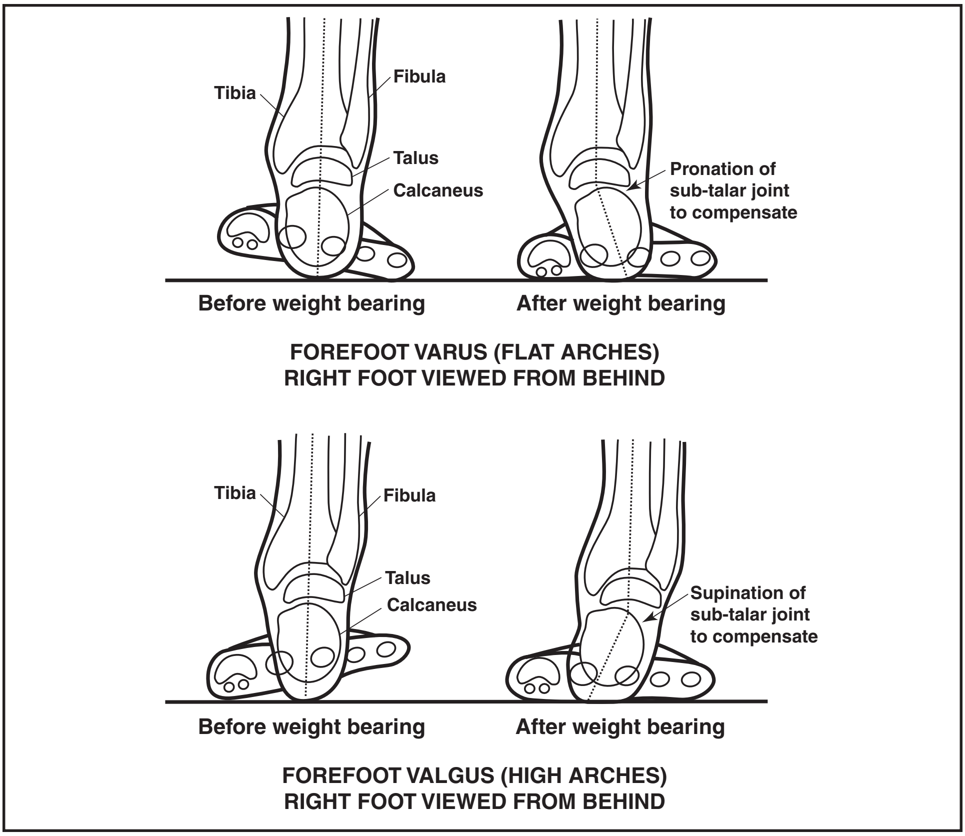

FIGURE 9.11—Forefoot varus and valgus conditions

forefoot valgus condition. When their foot is in a non-weight-bearing neutral position their forefoot has the fifth toe elevated relative to the first toe. And in order to compensate for this and bring the fifth toe to the support surface during weight-bearing, the sub-talar joint must articulate, causing supination, that is, the heel tilts outward. Those having high arches normally benefit from arch support under the medial longitudinal arch, the transverse and lateral longitudinal arch, and in particular, the midfoot area proximate the cuboid between the calcaneus and proximal head of the fifth metatarsal. An individual with either flat feet or high arches tends to experience greater rotation of the foot, and this can impart a twist to the Achilles tendon. To reduce the amount and rate of rotation that may be injuring the tendon, the individual might obtain more substantial arch support or a corrective orthotic—and perhaps a straighter lasted shoe (See Figure 9.11).

Seeing is Believing

The wear pattern on a runner's shoe can provide significant clues regarding the individual's biomechanics. To check their running form, videotape the individual running from the front, back, and sides. For the best results, videotape outdoors whenever possible. Despite what the lab researchers might claim, athletes do not run the same on treadmills. Athletes running on a level treadmill generally do not

use their hamstrings to the same degree as when running outdoors. And, experienced rearfoot strikers tend to use a flatter technique at footstrike and alter their way of going by loading the shoe more anteriorly, thus more closely resembling a midfoot or forefoot striker.

Injured athletes who are rehabilitating on a treadmill will later have to re-adapt to race well outdoors. The same phenomenon is observed with horses trained on treadmills. Tom Ivers, an author and equine trainer, has trained thoroughbreds on treadmills for many years. When horses come off a treadmill-training program, they are unable to race well on a natural surface. However, after a few weeks of training, including some uphill gallops, the required neuromuscular re-training and fitness of the hindquarters are brought far enough along to accomplish favorable racing results. The muscles in the hindquarters of a horse generally correspond to the hamstrings and gluteus muscles in humans (Ivers, 1994).

Things to Do

The best advice for a minor tendon injury of any kind is to let it rest. Comparing muscles to tendons in the early phase of healing, muscles respond to more aggressive forms of therapy such as light strength work and moderate stretching, but tendons for the most part need to rest. Tendons have much poorer blood supply than muscles, and take longer to heal. Athletes should take Vitamin C, since it promotes healing of connective tissue. Apply an ice massage to the affected area for at least 20 minutes before bedtime, and wear socks to bed in order to keep the area warm. This will speed up the local metabolic rate. Before taking the first step in the morning, athletes should draw out the ABCs with their affected foot, and perhaps use a heel lift with that first step. Further, a warm towel should be placed on the affected area first thing in the morning. In addition, it will help to carefully conduct some easy strength training exercises early in the morning, such as riding a stationary bicycle. Athletes should maintain an appropriate flexibility routine, but when afflicted with a tendon injury, runners should beware of over-stretching, and in particular, when they are not fully warmed up. They are well advised to run on soft but stable surfaces, and to wear long socks and sweats. In general, athletes should not be running without their warm-ups unless it is at least 60° Fahrenheit. Do not play the hero by braving the cold. This demonstrates ignorance or just plain foolishness. Replace athletic footwear that could be causing the problem. When in doubt, throw them out. Again, beware of wearing dress shoes, changing heel elevations frequently, and remedy any instability problems. Practice anonymous and random acts of kindness. This has merit and is reward enough in itself. Moreover, it will also make you feel better, and when you feel better, you heal faster.

Knee Injuries and Chondromalacia

Patello-femoral tracking problems and chondromalacia became the epidemic of the late 1970's and early 1980's. One of the underlying causes was a common practice of manufacturers at the time to incorporate heel flare, with the intention of enhancing footwear stability. The midsoles on many shoes flared out and became

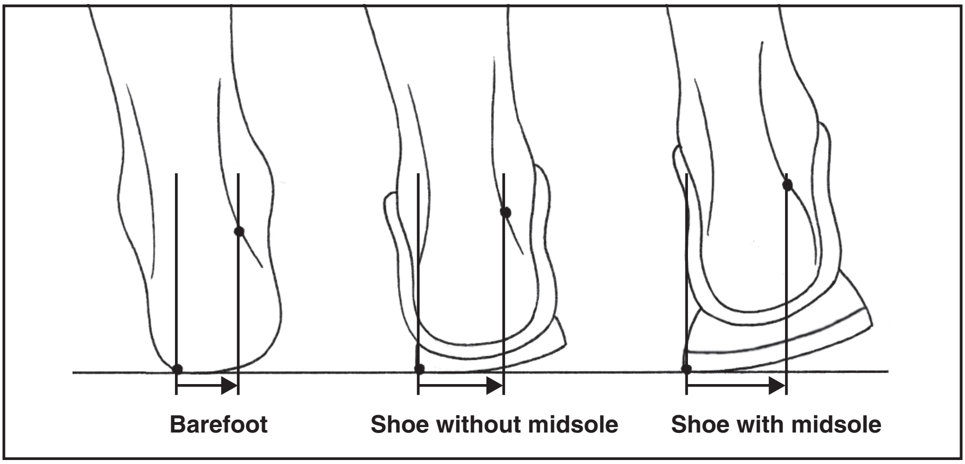

FIGURE 9.12—Rear view showing lever arm phenomenon

progressively wider, starting at the junction with the shoe upper and moving down towards the outsole. Instead of providing stability, this effectively increased the length of the lever arm extending from beneath the center of the heel towards the lateral side of the sole (See Figure 9.12). The increased length of this lever arm commonly resulted in greater pronation, and also a higher rate of pronation. Meanwhile, higher heel elevations were also introduced to improve cushioning, and this also tended to undermine stability. As a result, runners then suffered a relatively high incidence of tendon injuries near the knee (Nigg and Morlock, 1987).

Manufacturers have since reduced the amount of flaring used in the soles of athletic footwear. Further, attempts were made by Peter Cavanagh, then with Puma AG, and also Kenneth Misevich, with Etonic Athletics, Inc., to round the lateral edge of the sole in order to reduce this lever effect (as taught in U.S. Patent 4,449,306, and U.S. Patent 4,557,059, respectively). These attempts worked well in a laboratory setting on a treadmill, and when running on a flat surface. However, such footwear tended to facilitate inversion sprains when individuals ran on uneven surfaces, or improperly used the shoes for lateral movement sports. Today, most athletic footwear incorporate a slight bevel inclined at approximately 2-15° in the lateral rear corner of the sole.

Cavanagh also taught the use of softer foam material along the lateral side of the sole to decrease the lever effect and enhance cushioning (in U.S. Patent 4,506,462, assigned to Puma AG). This approach proved to be sound and has endured. Barry Bates, formerly with ASICS Corp., taught the use of firmer midsole foam on the medial side to reduce pronation (U.S. Patent 4,364,189). Later introduction of devices such as the Footbridge® also served to limit compression of the medial side of the sole, and thereby rearfoot pronation (U.S. Patent 5,046,267, Bruce Kilgore et. al, assigned to Nike, Inc.). The author is associated with patents (U.S. Patents 5,425,184, 5,625,964, and 6,055,746, assigned to Nike, Inc.) that teach the use of a groove delimiting a rearfoot strike zone, and a gas-filled bladder having relatively low stiffness in compression, to enhance both

cushioning and stability. This can reduce the effective length of the lever arm and the magnitude of the force imparted thereby. Much like the independent suspension found in many automobiles, the rearfoot strike zone as a whole can deflect and articulate. In addition, just like a tire, the gas-filled bladder is then placed near the point of impact for effective vibration isolation. In brief, reducing the relative stiffness of the rear lateral corner of the sole can decrease rearfoot pronation, and also the rate of pronation, thus providing relief to an athlete having an injured knee.

What's Their Deal?

Again, check the runner's conformance for conditions that might make the individual more prone to injury (e.g., a large Q-angle, substantial rearfoot or forefoot varus or valgus, bowed legs, and either high or low arches). Determine the individual's range of motion and strength while searching for a muscle imbalance. Notice the visible wear pattern on the training shoes. Observe and videotape the individual's running technique from all sides. Look for greater than normal pronation, tibial and femoral rotation, and the presence of a whip. Given a patello-femoral tracking problem, relatively straight lasted shoes may be beneficial.

Muscle Imbalances

A tracking problem of the patella can be caused by instability below the knee, but also by muscle imbalances associated with faulty running technique. What is the cause? With recreational runners, the following scenario may apply. They do not frequently run faster than 6:30 per mile, and often run at about the same speed on relatively level terrain. They are not only heel strikers, but also heel runners. They have learned to let the present generation of well-cushioned shoes do a lot of the work for them when running on hard asphalt. They often do not exhibit substantial hip extension or ankle flexion. They may have overdeveloped lateral quadriceps, but underdeveloped medial quadriceps, and hamstrings. This muscle imbalance can result in the patella being pulled into an orientation where it mistracks and rubs with more force than it should in the wrong place. In time, this can roughen the cartilage underlying the patella and cause chondromalacia.

Knee Extensions and Walking Squats to the Rescue

Normally, the quick fix for a patello-femoral tracking problem is to strengthen the medial quadriceps. The best way to accomplish this is to perform knee extensions, and in particular, to work the last 30° while pointing the toes outwards. If done properly, this single exercise probably does more than any other to correct a wandering patella. Leg presses, step-ups and 1/4-squats can also be done, but get things under control first with knee extensions. Walking squats—that is, stepping forward with one foot to do a "lunge," then stepping forward again with the other foot and repeating the sequence—simultaneously strengthens the medial quadriceps and hamstrings, and also enhances hip extension and ankle flexion. Begin by taking 10 steps in this manner, and then provide a full recovery. At the beginning, do not take a long lunge or dip with the opposite knee so deeply

that it touches the ground. Do not perform more than three sets of 10 steps. If athletes do too much, they could be sore beyond belief over the next two days. When they are able to take a fuller lunge step and touch the ground slightly with the opposite knee, then they are beginning to get into better shape. In a short time, fit athletes should be able to do this with a 15-pound barbell behind their head. And they can later progress by adding more weight. However, it is rare even for highly conditioned athletes to perform this exercise with more than 50 pounds on their back.

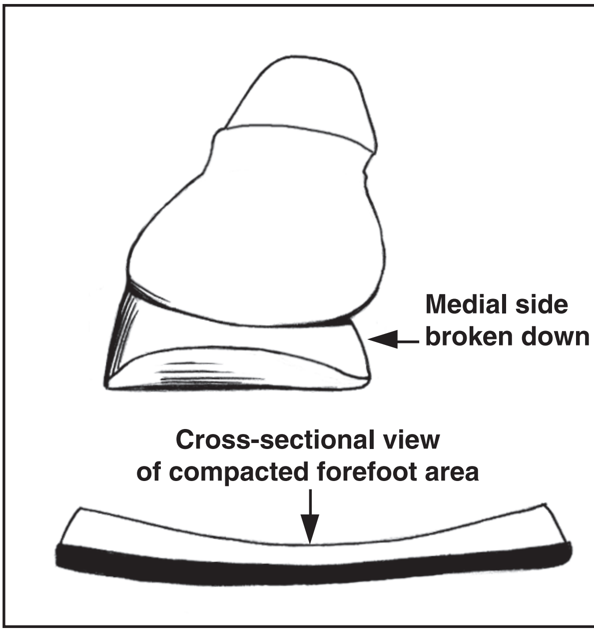

FIGURE 9.13

After leg extensions and walking squats, the most effective exercise to improve range of motion, and correct muscle imbalances is simply to go back to nature. Begin by walking and then running barefoot on a natural grass surface. Athletes who have had patellar tracking problems for years, and bounced from one form of therapy to the next, have recovered after a month of walking and running on golf courses.

Knee Joint Problems

Problems with the medial and lateral menisci, ligaments, or tendons, are generally the result of instability below the knee. What is happening below the knee needs to be identified and resolved. Normally, it is a case of too much inward rotation of the tibia and outward rotation of the femur. The toes are the primary forefoot mechanism for stabilizing inward rotation of the foot, whereas the connective tissues of the medial longitudinal arch and posterior tibialis are the primary midfoot mechanism. If neither of these successfully controls rotation, then unusually high loads will be passed on to the Achilles tendon and joint capsule of the knee.

Of course, the manifest injury at the knee needs to be treated. Obtain an accurate and concise history of the injury. Has the individual been running across a grade, or on steep uphills or downhills—and is this deviating their normal footpath? Is there a biomechanical problem? Does the runner pronate or supinate excessively? The presence of a whip will often work against the knee. Again, check the runner's conformance for conditions that make her or she more prone to injury (e.g., a large Q-angle, substantial rearfoot or forefoot varus or valgus, bowed-legs, and either high or low arches). Determine the individual's range of motion and strength while searching for a muscle imbalance. Notice the wear

pattern on the runner's training shoes. Observe and videotape the individual's running technique from all sides.

Get Out of Dying Shoes Before They Take You with Them

The degradation of a shoe sole can also cause knee problems. Often, the midsole will break down on the medial side, and also become compacted under the ball of the foot. (See Figure 9.13). This is generally not apparent on the outside of the shoe. Rather, look inside the shoes for compressed areas of foam material under the ball of the foot. Is there a pronounced bowl shaped depression there? The fact that many athletic shoes are made with foam midsoles already having a bowl shape in the forefoot area when viewed in cross-section along the transverse axis, probably does not help matters. This configuration may promote a smooth transition, and also help to offset the "edge effect," that is, the reduced stiffness often found at the edges of conventional midsoles made of foam material, but it probably promotes faster degradation of the central portion of the forefoot area where peak loads are commonly experienced. Does the shoe sit flat on a tabletop, or is the forefoot area of the sole deformed into a rounded, bowl shape? Sometimes the lugs located more centrally in the outsole will wear down first, and this also contributes to the formation of a bowl shaped footbed. This particular degradation of athletic footwear is often connected with knee problems. Such a shoe, when set on a tabletop and prodded from any direction, will oscillate to and fro. This is not a stable situation. Eject! Eject! Get out of dying shoes before they take you with them. New shoes, and perhaps shoes having firmer midsoles are in order. Curve lasted shoes are generally contraindicated for those with knee problems (See Figure 9.13).

What is Cheap, Light and Won't Last as Long as it Used To?

Most athletic shoes manufactured today use an ethylene vinyl acetate (EVA) closed cell foam material. This material is lightweight and inexpensive. It is not as heavy as the open-celled polyurethane foam often used in the late 1970's and early 1980's. However, EVA foam normally takes a compression set and breaks down faster than polyurethane foam—and the latter generally breaks down faster than higher quality, heavier, and more expensive foam rubber materials. The consumer is then getting an economical, lightweight and disposable shoe. When running 100 miles a week and swapping between two different pairs of training shoes, an athlete could reasonably expect to get six weeks, or about 300 miles, out of a pair of shoes—and it is probably not advisable to attempt more.

Iliotibial (I-T) Band Syndrome

Downhill running often contributes to the onset of an I-T band injury. Further, running downhill on streets having a transverse grade makes for an even more dangerous situation. Racecourses that include this condition are potentially hazardous to runners, particularly if this stretch comes late in the race when they are fatigued.

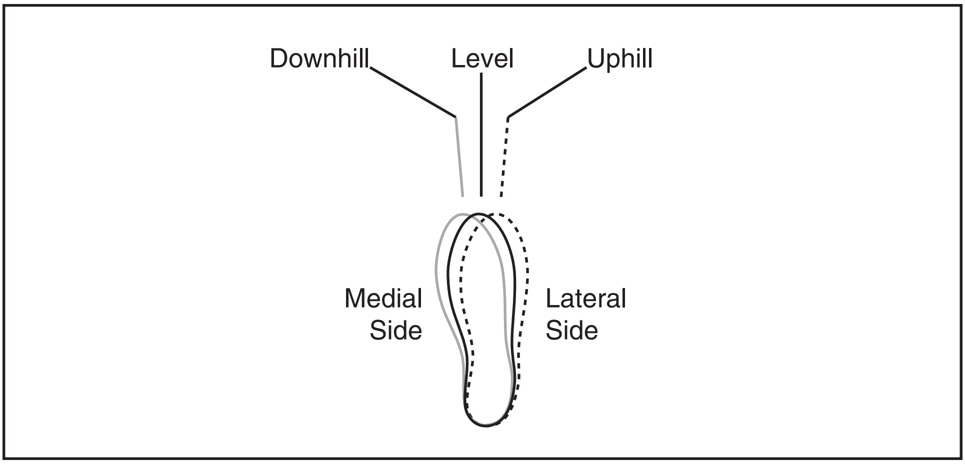

FIGURE 9.14—Deviated footpath running uphill and downhill

The Foot bone is Connected to the Leg Bone, the Leg Bone...

As Figure 9.14 shows, downhill running causes a medial deviation of footpath—that is, an individual's forefoot points inward (medially) more than normal. When running downhill there is more time for footfall after heelstrike, and this gives an opportunity for the foot to turn more medially. Often this inward deviation of footpath brings greater than normal rearfoot pronation, inward rotation of the tibia, and outward rotation of the femur. At the same time, greater than normal load bearing and braking can be taking place. As a result, the knee's lateral aspect can be over-loaded, and the IT band can suffer trauma as it is strained, abraded, and suffers micro-tears in the area near the lateral condyle of the femur. In contrast, uphill running causes the footpath to deviate just the opposite way—that is, the forefoot tends to point outward (laterally) to greater degree, and this tends to stress connective tissue on the inside (medial side) of the knee.

However, other things can also place unusual stress on the IT-band. Those who have a large Q-angle from wide hips, are bow-legged, supinate, or are midfoot and forefoot strikers, are more vulnerable. Again, note the runner's arch characteristics and any varus or valgus conditions. Is the individual running across a grade? Is there a visible whip? As always, check the wear pattern on the runner's athletic shoes, and in particular, look to see if the lateral side of the sole has broken down. Perhaps the stiffness of material on the lateral side of the shoe is not sufficient for the individual. Large or heavy runners should be especially attentive to this. The same stiffness of foam material or midsole device does not suit all.

Also look for excessive wear on the medial side of the forefoot (See Figure 9.15). This indicates instability, since individuals suffering I-T band syndrome will sometimes load their shoes transversely from the medial to the lateral side more than normal. Often, they have extremely tight quadriceps, particularly the lateral quadriceps muscle. These athletes will need to stretch this area well before and

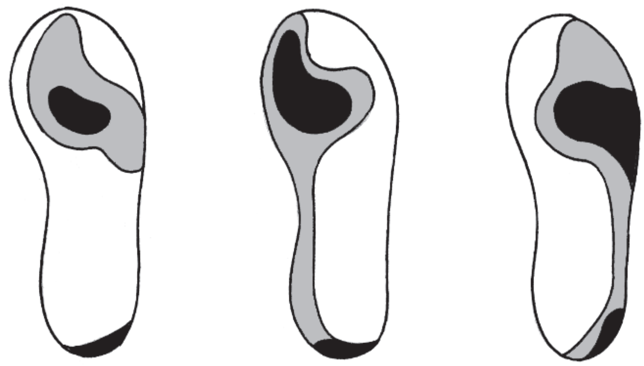

FIGURE 9.15—Adapted by permission, from T. Noakes, 1991, *Lore of Running*, 3rd ed., Champaign, IL: Human Kinetics, page 493.

immediately after training sessions. However, the quadriceps and I-T band are getting tight for a reason, namely, due to the way they are being used when the athletes run. So it will be helpful to videotape the athletes running from all angles, and share with them suggestions on how to improve their running technique. Often, correcting the situation requires specific exercises to improve their range of motion and strengthen the weaker muscle groups.

Plantar Fasciitis

Runners often refer to virtually any injury in the area of the arch as plantar fasciitis. Since there are multiple layers of connective tissue in this area of the foot that are difficult to isolate and discriminate, this broad definition will be accepted at face value. Obviously, there are a host of training errors, as well as a number of anatomical or biomechanical reasons why some individuals might be predisposed to getting plantar fasciitis. However, whereas Achilles tendonitis was perhaps the epidemic of the 1960's and early 1970's, and knee pain the epidemic of the late 1970's and early 1980's, plantar fasciitis was the epidemic of the late 1980's and 1990's—even to the present day. The former problems seem to have coincided with changes in shoe design. This more recent epidemic is probably no different. The question is why?

Heel Elevations Have Gotten Higher

One of the changes made in athletic footwear over the last twenty years has been an increase in heel elevation. The annual *Runner's World* shoe reviews used to rate the cushioning of the various shoes against one another, and everyone in the industry wanted to win the big cushioning showdown. The industry attacked the problem of cushioning and came to understand it reasonably well. Many manufacturers increased heel height to enhance the cushioning provided by

conventional foam materials. Some also increased heel height to facilitate insertion of new devices such as fluid or gas filled bladders in order to improve the cushioning of athletic shoes. However, higher heel elevations can introduce greater potential for instability.

When the Gizmo Fails

In the search of new technology, and in order to feed the insatiable marketing and consumption monster, many footwear manufacturers have introduced various devices into the soles of athletic shoes. A few of these gizmos work, but most do not—that is, they do not provide any better cushioning or stability than footwear made from conventional foam material. Simple is sometimes better. From the standpoint functionality and performance as opposed to fashion, many of the best athletic footwear values are presently found in the sixty to eighty dollar price range.

Athletes should also consider what happens when the gizmo fails in their athletic shoe. If a component inside the midsole fails, They might not recognize it. This is especially true of devices encapsulated in foam. Athletes may never recognize that a problem exists with the shoe, and might continue to run on faulty footwear for some time before making the discovery. As a result, athletes may mistakenly assume that an injury they suffered was due to a training error or chance, when it was actually defective footwear.

Generally, when a gizmo fails it reduces the stiffness of the midsole in the affected area and the wearer's foot then penetrates further into the midsole. When running, this can cause a functional leg length difference, which is well known to cause injury. Moreover, if the runner's heel or forefoot penetrates further into the midsole, then the plantar fascia can become impinged (e.g., upon a plastic part inside the midsole, or upon the conventional foam material underlying the arch area). The failure of a gizmo can also sometimes create a dysfunctional ledge in the arch area of the midsole upon which the plantar fascia can impact.

Stiffness Problems

Athletic shoes with relatively thick soles can be relatively inflexible. Depending on the configuration and intended use of the footwear, an inflexible sole can sometimes work against the plantar fascia. Flex grooves, such as those taught by E.C. Frederick et al. (U.S. Patent 4,562,651) and by the author (U. S. Patent 5,384,973) have been used to reduce the stiffness of athletic shoe soles. However, footwear that are too flexible in the wrong places can also cause problems. Athletes can check a shoe by placing the toe and heel between their hands and compress it to see where it bends. If it bends under the arch area instead of the ball of the foot near the metatarsal-phalangeal joints, then they could be in for a problem. Athletic footwear that include a cut-away or weakened area underneath the arch can be susceptible to this problem because they will sometimes flex in this area instead of beneath the ball of the foot.

FIGURE 9.16—Nike Zoom Celar track spike including substantial toe spring.

Toe Spring

Toe spring refers to the degree to which the sole of a shoe appears to curl upward in the forefoot area (See Figure 9.16). It can be roughly measured between the bottom of the sole and a flat underlying surface. The origin of toe spring derives from inflexible Dutch wooden shoes that required this configuration to be functional. It can give a relatively inflexible sole the ability to provide a smooth transition during the gait cycle.

Due to increases in the thickness of midsoles during the 1970's and 1980's, many athletic shoes have become less flexible. Toe spring has been widely used as a partial remedy. Transverse flex grooves have also been introduced to facilitate dorsiflexion of the toes. However, when wearing athletic footwear, it can be difficult or impossible for a wearer to stand on the ground and move the toes to a neutral or flat position as when barefoot. This situation can be dysfunctional, depending on the intended use of the footwear. Conventional walking and running shoes intended for normal use at relatively slow speeds should generally include little toe spring, because this best provides for stability and cushioning. However, it can be advantageous to include greater toe spring in footwear intended for running at high speeds. For example, a racing flat intended for the marathon can include more toe spring than a training shoe for running long, slow, distance work. Also, track spikes for sprinters can include more toe spring than those intended for middle distance and distance runners. Substantial toe spring in a sprint spike is functional because sprinters normally make most surface contact with their forefoot while sprinting. Thus, a sprint spike with substantial toe spring can facilitate a more rapid transition and less ground contact time. Unfortunately, the correct use of toe spring is not always well understood or implemented. Cosmetically, toe spring provides many athletic shoes with a sporty, automotive look. As a result, too many shoes include substantial toe spring at the present time. This is probably not a healthy situation. Peter Cavanagh questioned the widespread introduction of toe spring in athletic footwear during the early 1980's (Cavanagh, *The Running Shoe Book*, 1980).

A patent granted to the author (U. S. Patent 5,384,973, assigned to Nike, Inc.) contains relevant discussion of toe spring, and discloses the use of numerous longitudinal and transverse lines of flexion to enhance the functionality of conventional athletic shoes. This teaching and the competitive response of other footwear manufacturers have led to dramatic changes in the midsole and outsole configuration of athletic shoes. Whereas the forefoot area of athletic shoes once generally resembled a slab of foam material completely covered by an outsole, they now commonly include numerous grooves and segments to improve both cushioning and stability.

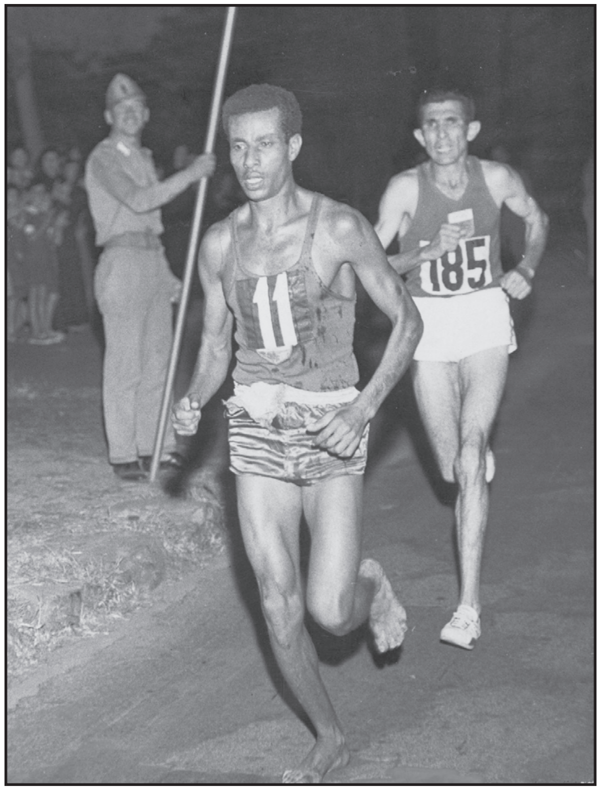

PHOTO 9.2—Abebe Bikila running barefoot in the marathon, 1960 Olympic Games. Photo from Hulton/Getty Images.

Abebe's Legendary Feet

Another cause of plantar fasciitis can stem from a runner having poorly conditioned feet. Abebe Bikila won the 1960 Olympic Games marathon in Rome while running barefoot. Athletes can sometimes be enlightened about the need to condition their feet by attempting to run barefoot for two miles on asphalt. The problem will not be blisters on their tender feet. Instead, the intrinsic muscles of their feet will become exhausted. Few athletes do anything to train their feet, but rather imagine their feet to be in good condition simply because they run a great deal. This is not the case. Many runners exhibit a limited range of motion in their ankle and toes, and also have weak intrinsic foot muscles. When confined to the "splint" of a running shoe, the foot (which is the most basic piece of equipment needed for distance running) can in fact be the least conditioned.

Get Back to Nature

The simple answer is to get back to nature. Asphalt and athletic shoes are recent inventions. Whenever it is practical and possible, walk and run barefoot on a grass surface. However, gradually increase both the distance and intensity of the barefoot workouts (See the discussion in Chapter 2). Generally, it is difficult to find a natural surface where one can run safely. When on school grounds, it is always wise to first jog a lap while wearing shoes and inspect the area for any hazardous

material. If athletes can at least warm-up and warm-down while running barefoot on the infield grass, it will pay big dividends by preventing injury and enhancing their running technique.

Listen for the Canaries

The initial injury that commonly sets plantar fasciitis into motion is a slight strain to muscle, tendon or fascia in the medial longitudinal arch. If rested, it will often clear up within three to four days. Athletes often completely ignore the earliest symptoms of the developing problem. They fail to pay heed to the initial muscle strain, and that is truly when the canaries stop singing. If athletes do not rest the injury, then the resulting loss of elasticity and the body's defensive reflexes will often induce greater stiffness in the arch area, and a more serious injury. Running will only make things worse. Nip plantar fasciitis in the bud. It is far better to resolve the little muscle strain by taking three to four days off than to ignore it and conduct a hard workout on the injury. If athletes make that mistake, they may face a more serious injury. The injury will normally travel towards the origin of the plantar fascia, and eventually reach it at the calcaneus. At this point, disruption of the bone surface (or periosteum) can occur, and result in the development of a bone spur. Appropriate therapy includes rest, ice massage, wearing socks to bed to keep the affected area warm, taking Vitamin C, performing ankle ABCs before taking the first step, and placing a warm towel on the affected area in the morning.

Arch Support is Essential

The aforementioned measures can help, but normally athletes will need a customized insole or lift to reduce both the mechanical loading and the plantar pressure being placed on the plantar fascia. To relieve pain and avoid further local trauma, a hole can be made in the insole or lift to accommodate the swollen or affected area. This can be especially beneficial if the injury has progressed to the origin of the plantar fascia on the bottom of the calcaneus, or heel. The author once advised Air Jordan® designer Tinker Hatfield to use this technique with Michael Jordan when he was afflicted during the NBA Championships, and it provided such immediate relief that Jordan requested his golf shoes be made in the same manner. Athletes can go months or even years with symptoms of plantar fasciitis unless they remedy inadequate arch support. In this regard, flimsy women's dress or casual shoes without arch support can sometimes be the problem for female athletes. It is sometimes advisable for women to discontinue wearing these types of shoes during the day.

Regardless of gender, the introduction of a customized insole or orthotic device can go a long way toward resolving plantar fasciitis. Unfortunately, most of the insoles provided in present athletic footwear are relatively flat, and lack arch support. In contrast, some of the insoles provided in previous decades were of superior quality, and frequently included a generic shaped latex rubber foam arch support. Insoles with cupped formations about the heel and sides of the foot were also sometimes commercially available (e.g., in the Lydiard EB Brütting AG brand shoes, and also those made by Etonic Athletics, Inc.). However, most manufactur-

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United States Patent [19]

Lyden

[11] Patent Number: 5,632,057

[45] Date of Patent: May 27, 1997

[54] METHOD OF MAKING LIGHT CURE COMPONENT FOR ARTICLES OF FOOTWEAR

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[21] Appl. No.: 510,433

[22] Filed: Aug. 2, 1995

Related U.S. Application Data

[63] Continuation of Ser. No. 275,642, Jul. 14, 1994, abandoned, which is a continuation of Ser. No. 74,771, Jun. 9, 1993, abandoned, which is a continuation-in-part of Ser. No. 976,407, Nov. 13, 1992, abandoned, which is a division of Ser. No. 805,596, Dec. 11, 1991, Pat. No. 5,203,793, which is a continuation-in-part of Ser. No. 714,971, Jun. 13, 1991, Pat. No. 5,101,580, which is a continuation of Ser. No. 410,074, Sep. 20, 1989, abandoned.

[51] Int. Cl.[6] A43D 1/00; A43B 7/14

[52] U.S. Cl. .... 12/146 B; 12/146 M; 36/93

[58] Field of Search .... 12/146 B, 146 M; 36/93, 88, 89, 90, 92

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Primary Examiner—Ted Kavanaugh

[57] ABSTRACT

A method for making a conformable device including a light cure material for use in functional relation with an article of footwear in order to enhance conformance or fit, support, comfort, and cushioning. The present invention can serve to accommodate the unique anatomical features and characteristics of an individual wearer and finds application within numerous types of articles footwear (44).

20 Claims, 11 Drawing Sheets

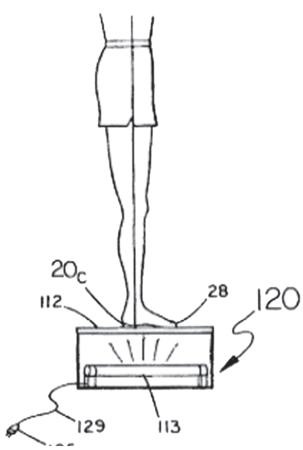

FIGURE 9.17—U.S. Patent 5,632,057

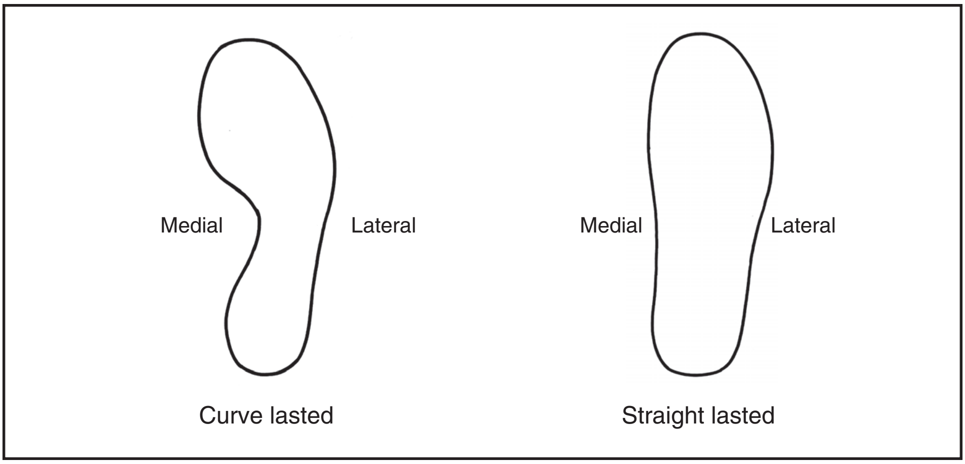

FIGURE 9.18—Curved versus straight lasted shoes

ers are currently not spending the money to provide consumers with a quality arch support and insole. If you want a better product, then demand it, and vote with your dollars. Dollars and public goodwill are what corporations understand.

An insole providing arch support can substantially improve the fit of a shoe and reduce inward and outward rotation of the foot (Cavanagh, *The Running Shoe Book*, 1980). Improving conformance under the plantar aspect of the foot can also effectively increase the surface area of the midsole being worked. A well-designed insole can then reduce local plantar pressures, and enhance cushioning, stability, comfort, and overall performance. The general public would benefit greatly from an insole providing enhanced conformance and support. Relatively few people actually require correction and prescription orthotics. When in doubt, seek out a qualified medical professional. Approximately 20% of the population have a high risk of injury when they engage in exercise without proper orthotic correction. Generally, a semi-rigid or flexible orthotic is preferable to a rigid and inflexible orthotic. The connective tissue of the plantar fascia requires adequate room to flex during exercise, like the more visible muscles and tendons of the hand and arm. The use of rigid orthotics, or those with too much correction, can sometimes impede the plantar fascia and cause a problem. A patent granted to the author addresses the need for a fast, effective and relatively inexpensive method of providing custom insoles (U.S. Patent 5,632,057). This patent teaches the use of a light table to photocure a conformable insole under the wearer's foot in approximately one minute (See Figure 9.17).

Straight versus Curved Lasts

The late Bill Bowerman and Arthur Lydiard once debated the merits of straight versus curve lasted shoes, with Bowerman favoring straight lasted, and Lydiard favoring a more curve lasted shoe (see Figure 9.18). They were both correct. When running at relatively slow speeds, about 80% of distance runners are rearfoot strikers, that is, they impact the lateral rear corner of the shoe sole. The center of plantar pressure then passes more or less up the middle of the sole

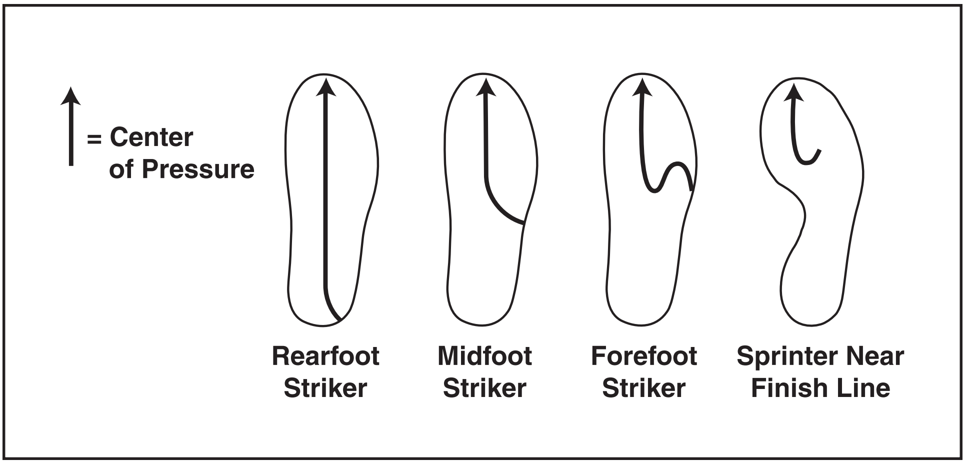

FIGURE 9.19—Center of Pressure

before exiting between the big toe and second toe (See Figure 9.19). A straight lasted shoe is normally more stable for those who run at relatively slow speeds, and also for those who have flat arches or motion control problems. Curve lasted shoes provide less medial support while running at slow speeds, and generally, they should be avoided by those individuals having flat arches or motion control problems.

However, when running at progressively higher speeds, athletes normally become midfoot and forefoot strikers. The center of pressure will then travel inward, and sometimes also rearward in the midfoot or forefoot area, before exiting between the big toe and second toe. Therefore, when athletes run at higher speeds in a curve lasted shoe, the loads tend to be shifted away from the medial side. With increasing speed, many also tend to abduct (or point the forefoot more laterally) and place more load on the big toe. Accordingly, a curve lasted shoe then may not undermine stability when athletes are moving at higher speeds, and rather, can actually facilitate movement. Curve lasted shoes tend to provide superior performance when runners are midfoot or forefoot strikers, and when they are running faster than 6:00/mile pace. Nevertheless, the vast majority of the public does not do a significant portion of their running under 6:00 /mile pace, and that is approximately the speed at which most individuals transition from being a rearfoot striker to more of a midfoot or forefoot striker. So, when in doubt, play it relatively straight. Some individuals simply prefer the fit provided by one or the other configuration. Most manufacturers today are making so-called semi-curve lasted shoes, which effectively split the difference.

Neuroma

Nerve tissue can sometimes become impinged or bruised in the foot, particularly between the metatarsals. A neuroma consists of swollen and possibly enlarged nerve tissue. It can be caused by acute trauma, such as being kicked while playing soccer, or even by running or jumping on hard surfaces. Overtightening

PHOTO 9.3—Bill Bowerman and Arthur Lydiard at Hayward Field, Eugene, Oregon, 1996. Photo courtesy of Nobuya Hashizume.

the laces of athletic shoes, especially track spikes, can narrow the foot and cause the metatarsals to impinge upon a nerve. Again, check if the forefoot of the athletic shoe has degraded and includes a bowl shaped impression under the ball of the foot. This can cause the metatarsals to migrate towards one another and induce a fallen transverse arch, thus entrapping and injuring a nerve.

Shin Splints

Often, the first time young distance runners participate in high school cross-country or track, they will get shin splints. It is a case of too much too soon. The transition from complete inactivity to running a few miles each day constitutes a leap from zero to several thousand impacts and repetitions—each involving approximately two and a half body weights. Beginners also tend to have faulty running technique, and are easy prey to motion control problems. Often, they are neither aerobically conditioned, nor muscularly strong. Further, their running form often degrades markedly because no motor memory has yet been instilled to maintain optimal biomechanics when they are fatigued. Young athletes returning from a run are sometimes physically and mentally exhausted.

The best prevention is to make certain that young runners begin with low mileage, wear good footwear, and run slowly on forgiving surfaces. Once shin splints arise, runners are often stuck with them for a while—that is, if they continue with an exercise program without taking a rest. Shin splints will often

stay with athletes for an entire season, but will disappear after a month of rest. The use of ice and anti-inflammatory drugs can make athletes feel better, but time and rest is what they really need to get better. The problem is not normally encountered thereafter, provided they continue a nominal level of training. The equivalent of shin splints in a horse is called bucked shins, and this also happens when too much is attempted too soon.

True shin splints are an inflammation of connective tissue between the tibia and fibula. However, athletes will refer to virtually any pain along the medial edge of the tibia as shin splints. This is usually a form of tendonitis near the point of origin for the muscles of the lower leg, where the muscles transition into tendon tissue or where the tendons attach to bone. Hot spots on the bone are then common. These can develop into stress fractures, but the latter will generally not show up on X-rays until 10 to 14 days after the injury is noticed. Again, excessive pronation and tibial rotation can cause shin splints. Young athletes just beginning to train, or individuals who have recently increased their training dramatically are especially vulnerable. In any case, individuals having a motion control problem, and in particular, excessive pronation, could need correction.

Inversion Sprains and Peroneal Injury

Inversion sprains and peroneal injuries are not often associated with running. Perhaps, the exception being when a runner turns an ankle while running across a grade, or accidentally steps into a pothole during cross-country. However, during the track and field season, this injury most often happens when several athletes play pick-up basketball after practice. Commonly, the victim will make a vertical leap and come down upon another player's foot, thus spraining an ankle. However, if none of these circumstances seem to fit, then determine whether the lateral side of the sole is too soft for the individual, or has suffered degradation. Further, observe the runner's conformance, and be on the lookout for bowed legs or a rearfoot varus condition. Is the athlete a supinator, or running on a road with a grade? Any one of these conditions, and certain combinations, will increase the risk of an inversion sprain.

Bunions

Lateral deviation of the big toe at an early age is a problem directly associated with the use of conventional footwear (Staheli, 1991). Native peoples do not have a laterally deviated big toe. Instead, their big toe lines up directly with the first metatarsal (Hoffman, 1905, James, 1939, Sim-Fook and Hodgson, 1958). Even later in life, the foot has some capacity to change and adapt. Those who stop wearing restrictive shoes and start walking and jogging barefoot will generally improve their range of motion and strength—and their big toe will tend to align itself more medially. A laterally deviated big toe can decrease one's ability to stabilize the foot against inward rotation, and can thereby cause a whip, since it may not be able to maintain the foot in a balanced position during toe-off. In

particular, if the foot is inwardly rotated at toe-off, the ground reaction forces generally cause lateral movement of the foot as it begins the flight phase, and this can result in a whip.

A confining shoe upper that causes the big toe to deviate laterally, can contribute to the formation of a bunion. Further, the combination of a confining shoe upper and excessive pronation (which abnormally stresses the joint capsule of the big toe) can greatly accelerate the formation of a bunion. Women more frequently have problems with bunions. Many women think they are supposed to have small feet, and better yet, small, pointy feet. So they wear small, pointy dress shoes, which is the modern day equivalent of foot binding. This gives them bunions and ugly, painful feet. However, the present generation seems to better understand that shoes ought to be made to actually fit the human foot and provide plenty of room for the toes.

Posterior Tibialis

Just as the toes are the primary stabilizer regarding inward rotation in the forefoot area, the posterior tibialis is the primary stabilizer with respect to inward rotation in the midfoot area. Again, to a lesser degree, the intrinsic muscles of the foot, particularly those in the medial longitudinal arch, can also stabilize the medial aspect of the midfoot. Moreover, the tendon of the posterior tibialis can become overworked and inflamed when an individual has a motion control problem. Beware of soreness near the insertion, at the bend near the protuberance below the ankle, and also near the origin on the medial side of the tibia. An injury to the posterior tibialis will often travel in a direction from the point of insertion to the origin. If the injury has reached the origin, then a hot spot can develop and eventually cause a stress fracture of the tibia. Athletes with flat feet are the most vulnerable—they often have forefoot varus. In any case, injury to the posterior tibialis is normally caused by over-pronation, an excessive rate of pronation, and inward rotation of the midfoot. If an athlete has flat feet, it is best to avoid curve lasted shoes. Orthotics, or insoles that provide adequate arch support, can stabilize the medial longitudinal arch, and prevent an injury to the posterior tibialis, or alternately, can facilitate recovery.

The Hip Joint

Injuries involving the hip are less frequent than problems with the foot, lower leg and knee. The latter structures can usually isolate any motion control problems before they reach the hip. However, if an athlete is suddenly afflicted with a hip injury, check to see whether the individual has been running downhill or on a slippery surface. Downhill running can induce greater than normal hip extension and cause a slight tearing of the connective tissue near the hip joint. If one is looking from the side at an athlete facing to the right, the affected area is usually just behind and above the joint at about 10 o'clock. Running on a slippery surface at high speeds can cause the same condition. A "slip-and-jerk" reaction takes place. Perhaps the athlete has been running on wet barkdust, mud or snow.